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A MODERNISTIC BRIDGE AT AN OLD SITE

Design Features, Construction and Cost Items of New Structure near Chicago

By JOHN C. BLACK
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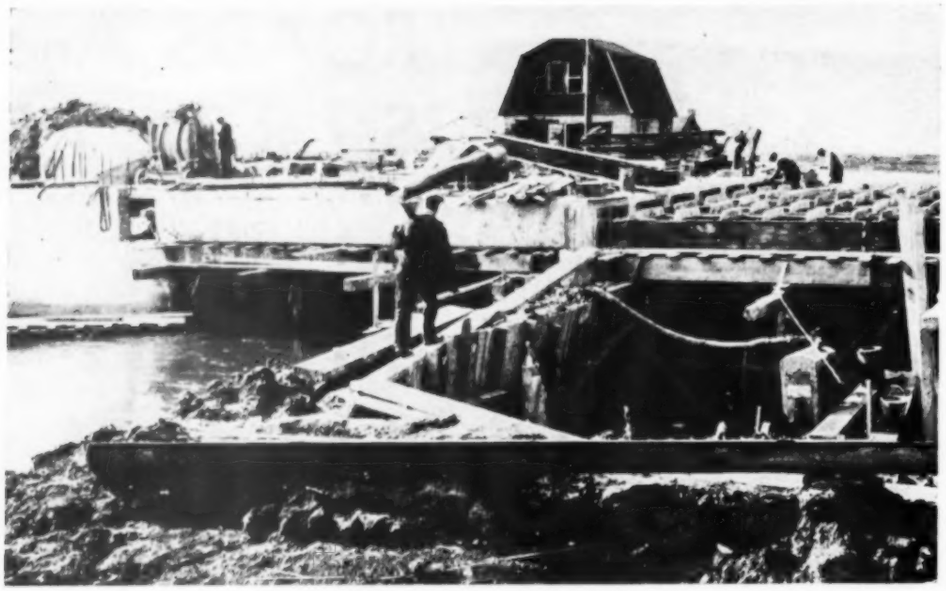
All Photographs by the Author

SEVERAL small bridges of interesting design were built in 1935 in the northeastern part of Cook County, Illinois. Typical of the group is the one carrying Willow Road over Skokie River—known locally as Skokie Ditch. While ordinarily of small size, this stream is subject to annual floods which heretofore have spread across the entire Skokie valley, creating a distinct nuisance though seldom doing serious damage. Work by the Civilian Conservation Corps during the past two years has brought the stream under control, and new bridges are located and designed to conform therewith.

Design and Dimensions

The bridges are all of the simple beam, concrete girder type, supported on concrete abutments and piers. All carry a 44 ft. roadway and two 5 ft. 2 in. sidewalks. The Willow Road structure has 3 spans of 28 ft. 0 in. each, measured to center line of joints between girder ends. Its abutments and piers rest on blue clay without

Willow Road Bridge as It Appeared from the Northeast, June 3, 1936.



View from the North, May 15, 1935, Showing Dam Protecting Center Span Falsework from the River

pile support. The overall width is 57 ft. 8 in., divided as follows:

Roadway	44 ft. 0 in.
2 Curbs	1 ft. 4 in.
2 Sidewalks	10 ft. 4 in.
2 Rails	2 ft. 0 in.

The length from end to end of the three girders is 84 ft., and the corresponding horizontal area is 4844 sq. ft.

The abutments are U-shaped, with faces 60 ft. 8 in. long and wing walls 29 ft. 0 in. long. Footings are 9 ft. 6 in. wide by 2 ft. 0 in. thick, reinforced both sides. The face walls are 15 ft. 1¼ in. high, 18 in. thick at top, 20 in. at bottom, and reinforced in both faces. Wing walls are of the same thickness. There are no buttresses or counterforts. Abutment corners are rounded to a radius of 18 in., and the ends of wing walls are also rounded.

Pier footings are 2 ft. 0 in. thick, 7 ft. 0 in. wide, and extend 8 in. beyond ends of pier walls. They are reinforced laterally with ½ in. square bars, hooked at the ends and spaced 9 in. on centers. Longitudinal reinforcement consists only of three ½ in. bars in the lower face of the slab. The underside of the slab is approximately 5 ft. below stream bed. The main portion of each pier is a single reinforced wall 15 ft. 2¼ in. high, 60 ft. 8 in. long, and 3 ft. 0 in. thick for its entire height. Its ends are rounded. Pockets are cut into the pier tops to provide space for the plates and rockers on which the girders rest.

There are 10 girders in each span. Each girder is 1 ft. 5 in. wide with seven 1¼ in. square reinforcing bars distributed in two rows at the bottom. Web reinforcement is with ½ in. square bars. The 2 girders nearest the center line are 2 ft. 4 in. deep—the outside girders 2 ft. 0 in.—with the others graduated between. This keeps the bottom elevation uniform while providing for a 4 in. roadway crown.

The girders of each span are joined at their ends by cross beams 1 ft. 7 in. deep. The bridge slab is 7 in. thick, reinforced top and bottom. The angles between slab and girders and between slab and cross beams are given a 6 in. fillet. Girders, beams and slab were poured as a unit. An expansion joint with guard is provided at each pier.

Pavement, Railings, Drainage

The pavement is a 4 in. surface of high early strength concrete, laid directly on the bridge slab. Eight inch curbs separate it from the sidewalks which also are of concrete

Side railings and posts are of reinforced concrete in a banded design, the artistic character of which is shown in the illustrations. It is a pleasing variation from the standard pierced guard of Illinois and other states, which, though good in itself, becomes monotonous when used exclusively. Though not shown in the pictures, there is a ½ in. space between the posts and the ends of railings.

Bridge pavement and sidewalks drain through scuppers on opposite sides of the curb, while the approach slabs have drainage inlets at each side. These lead through 6 in. clay pipe to 24 in. corrugated iron discharge pipes, with flap gates in the abutment walls. There is also a system of tile drains back of each abutment wall to collect ground water and relieve pressure.

Building West Span Falsework, May 24, 1935. View Looking Southwesterly

Temporary Bridges

As Willow Road is an important thoroughfare, a detour was necessary during the construction period. This involved some 500 ft. of temporary graded roadway and two timber trestles—one 132 ft. long over the main stream, and the other 22 ft. long over a side ditch. Each trestle carried a 24 ft. roadway and a single 5 ft. sidewalk. The width over guard rails was 31 ft. 0 in. Bents were spaced 11 ft. 0 in. on centers. Piles were 20 ft. long, and there were 5 piles to each bent. The graded portions of the detour were given a 20 ft. surface of crushed stone.

The costs were $4,507 for the structures and $3,197 for grading and surfacing—Total $7,704. In the final

estimate, items pertaining to this work are indicated by the letters "T.B."

The combined horizontal area of the two bridges was 4,774 sq. ft., and their cost per square foot was $0.94.

How Flood Water Was Handled During Construction

Throughout most of the construction period the water problem was not a serious one for the contractor; but a heavy May flood threatened interference with operations and damage to uncompleted work.

At that time the piers and abutments were in, the east span was completed, though falsework still remained, forms were being built for the middle span, and west span falsework was about to be started. The stream had been dyked and was flowing entirely through the east opening. A short dam of timber sheeting with a clay core extended from each end of the east pier to the temporary dykes.

High water was reached on May 13 and 14, at a level about 13 ft. above the pier footing. There was considerable leakage at this time through both dams, but not more than could be adequately handled by a 4 in. centrifugal pump. Leakage was greatest where the dams joined the pier, but was checked with sand bags placed by a man in a wading suit. A mud sucker was used to do the clean-up pumping from around the falsework of the middle span.

The Bridge as Seen from Northwest, June 24, 1935.

When the water level dropped about a foot from its high point, the leakage largely ceased, and this was the condition on May 15 when the accompanying photographs were taken.

Past, Present and Future

The history of this stream crossing is not fully known, but apparently at least 3 bridges preceded the present structure. When the abutment of its immediate predecessor was removed, the remains of an older abutment were found back of it, while groups of old piles indicated that a still earlier bridge had stood there.

How long will the new bridge last? *Quien sabe?* Its roadway is 44 ft. wide—26 ft. more than the Willow Road pavement approaching it, which, though not ideal, suffices for the present. That Willow Road must be widened some time is certain; probably the time will be soon; but one can only guess as to when traffic will grow up to and exceed a 44 foot requirement. As to physical durability, it is safe to assume that construction will outlast traffic adequacy.

Cost

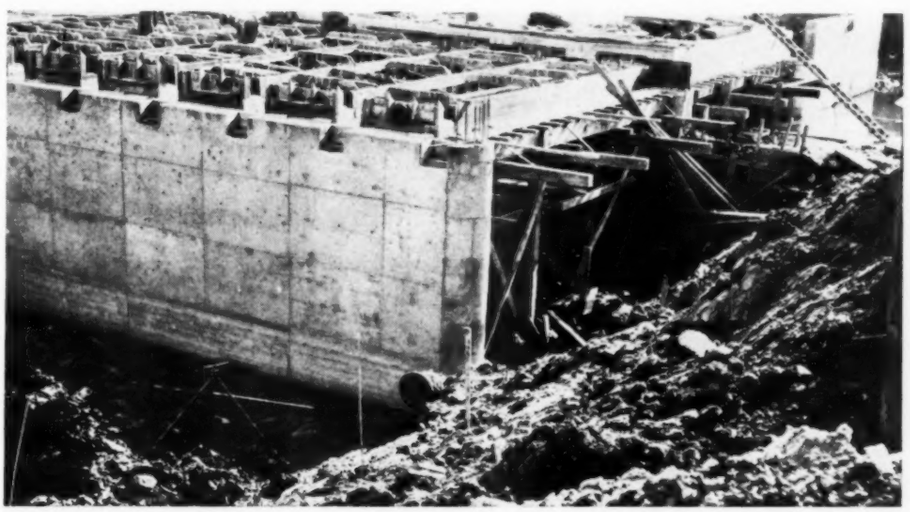
The contract cost of the project was $45,406.50 to which must be added $6,224.03 for cement which, as is customary on this class of work, was furnished by the county, thus making a total of $51,630.53 exclusive of engineering and overhead. This cost, however, should not be used for comparative purposes, as it includes several items which were either extraordinary in character or pertained only indirectly to the bidge. The most important of these are as follows:

Storm sewers	$ 2,308
Approach pavement slabs	3,111
Removing and installing water main	3,427
Constructing special gutter	1,393
Patching pavement	4,421
Temporary bridge and road (total all items)	7,704
Total	$22,364

Deducting this from the total of $51,630 leaves $29,266 as the cost of the bridge proper. Figured on the basis of 4,844 sq. ft. horizontal area covered by the 3 spans, the cost per square foot is $6.04.

The final estimate shows the following details.

Description	Unit of Measurement	Contract Price	Quantity	Amount
Class "X" conc. excl. of reinf. steel	Cu. Yds.	$14.40	875.4	$12,605.76
Steel reinforcing bars	Lbs.	.035	117,680	4,118.80
Cast iron rockers	Lbs.	.045	5,780	260.10
Steel bearing plates	Lbs.	.045	1,915	86.18
Name plates	Each	40.00	2	80.00
Channel excavation	Cu. Yds.	.40	2,000	800.00
H. E. S. 4" P. C. C. pav't.	Sq. Yds.	.90	407	366.30
Curb	Lin. Ft.	.80	110	88.00
Struc. steel expansion guard	Lbs.	.05	2,520	126.00
Earth excavation	Cu. Yds.	1.00	50	50.00
Borrow T. B.	Cu. Yds.	.60	430	258.00



View from the Southwest, May 15, 1935. West Pier at Left; River and Dam at Upper Right. Form Construction for Center Span Shows Bevels to Make Fillets Between Slab and Girders

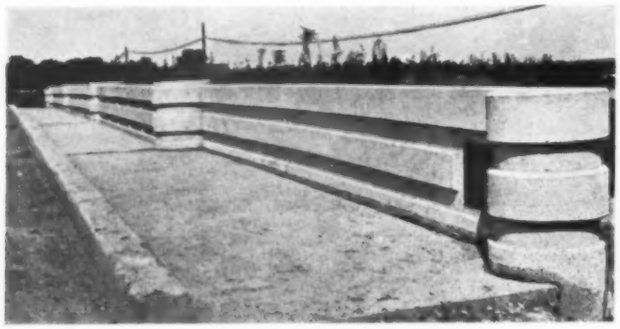
Steel wire mesh reinforcement	Sq. Ft.	.03	715	21.45
T. B. furn. untreated piles, 20 ft. long	Lin. Ft.	.20	1,420	284.00
Driving piles T. B.	Lin. Ft.	.20	1,270	254.00
Excavation and backfill	Cu. Yds.	.56	1,740	974.40
Old masonry removal	Cu. Yds.	3.50	156	546.00
Handrail conc. Class X	Cu. Yds.	30.00	35.3	1,059.00
Guard rail	Lin. Ft.	.82	426	349.32
Sand, gravel or C. S. backfill	Cu. Yds.	.68	1,080	734.40
Earth excavation T. B.	Cu. Yds.	1.00	50	50.00
Broken stone T. B.	Cu. Yds.	3.45	507.5	1,750.88
Stone chips T. B.	Cu. Yds.	3.50	325.12	1,137.92
Rip Rap	Sq. Yds.	1.00	155	155.00
Storm sewers, 24-in.	Lin. Ft.	2.00	1,154	2,308.00
Cor. I. P. 24-in.	Lin. Ft.	2.25	24	54.00
Tile drains 6-in.	Lin. Ft.	.40	620	248.00
Tile drains 12-in.	Lin. Ft.	1.50	16	24.00
Frames and grates	Each	15.00	4	60.00
Catch basins	Each	75.00	1	75.00
Floor drains	Each	2.25	48	108.00
Flap gates	Each	20.00	3	60.00
Struct. timber T. B.	MBM	70.00	56.7	3,969.00
Pav't removal	Sq. Yds.	.40	827	330.80
H. E. S. P. C. C. pav't	Sq. Yds.	1.60	1,944.6	3,111.36
Earth shoulders	Sq. Yds.	.12	1,025	123.00
Crushed stone No. 3	Cu. Yds.	2.50	19	47.50
Total				$36,674.17

Miscellaneous Deductions and Extras

	Deductions	Extras	
Deduct for 10,448 empty sacks	$1,044.80		
Item 1—removing and installing 12" water main		3,427.05	
Item 2—constructing special gutter		1,392.65	
Item 3—patching pav't bet. Skokie Blvd. and Hibbard Road		4,421.15	
Item 4—labor assisting engineer		576.15	
Cement furnished by contractor		264.83	
Cement sold to contractor	304.70		
Total	$1,349.50	$10,081.83	
Net extras after deduction			8,732.33
Grand total			$45,406.50

The bridge was designed and construction was superintended by the Cook County Department of Highways. It was opened for traffic in the latter part of 1935. Arcole Construction Co., of Niles Center, Illinois, was the contractor.

Winter construction on one of the similar bridges mentioned at the beginning of this article was described and illustrated on pages 99 to 101 of ROADS AND STREETS for March, 1935. This bridge crosses the Skokie at Dundee Road about 3 miles north of Willow St., and was also built by the Arcole Construction Co.

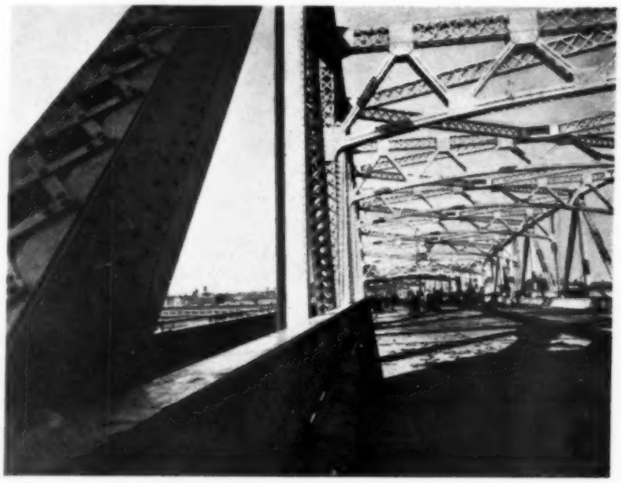


The Rail Always Shows a Pleasing Combition of Light and Shadow

Tri-Borough Bridge Has Large Amount of Welded Structural Silicon Steel

The new Tri-Borough Bridge, spanning the Harlem River between Randall's Island and Manhattan, and also crossing Ward's Island and Hell Gate to Queens, which will be opened to traffic this midsummer, is stated to represent the largest use of welded structural silicon steel ever recorded in bridge construction.

The flooring of the lift span units is the "battledeck"



Tri-Borough Bridge, Showing "Battledeck" Floor Composed of Structural Silicon Steel Plates Fused Together by Shielded Arc Welding

type composed entirely of 5/8 in. structural silicon steel plates with a 1 in. wearing surface of asphalt plank. The plates are welded together by 5/8 in. butt welds and by 1/4 in. fillet welds to each flange of the longitudinal floor beams. Approximately 3,000 ft. of butt welds and 1,500 ft. of fillet welds were required for laying the 350 ft. of flooring for the Bronx lift unit, the Manhattan unit requiring somewhat less. The welding was done with "Shield Arc Eighty Five" electrodes, made especially for welding high tensile steel by The Lincoln Electric Co., Cleveland, O. Many Lincoln gasoline engine driven "Shield Arc" welding machines were also used.

Specifications and procedures for the welding were worked out by the consulting engineers, Ash, Howard, Needles & Tammen, in conjunction with arc welding engineers of The Lincoln Electric Co.

The arc welding operators were required to pass a qualifying test by producing welds having a tensile strength of 76,000 lb. per square inch, and ductility of 20 per cent elongation in 2 in. in outside fibers. These requirements were exceeded. Actual figures showed tensile strength of approximately 90,000 lb. per square inch and 35 per cent elongation in two inches.

The project comes under the Tri-Borough Bridge Authority of New York. The two main welding contracts, for the Bronx and Manhattan approaches, are being carried out by The Bethlehem Steel Corporation and Taylor, Fichter Steel Company, Inc. Working schedules call for opening the bridge to traffic July 1st.

SPEED ESSENCE OF MISSISSIPPI ROAD PROGRAM

Construction Details and Organization for Carrying Out $42,500,000 Program

By VICTOR J. BROWN
Publishing Director, Roads and Streets

PROVISION was never made in the State of Mississippi for a comprehensive road building program until January, 1936, when the new legislature, immediately, upon convening for its first session, passed a bill providing for the issuance of $23,000,000 in State notes covering a PWA loan in that amount. Of this, $18,500,000 is to cover Mississippi's 55 per cent of a PWA project and $4,500,000 is to be used to match her share of regular federal aid for the fiscal years 1936 and 1937. The 45 per cent grant amounts to $15,000,000. Adding these figures, the following is obtained:

$18,500,000—45-55 basis loan
15,000,000—45-55 basis grant
4,500,000—PWA loan
4,500,000—regular federal aid

Total $42,500,000

Mississippi, by putting up $23,000,000 in borrowed money from the PWA is getting $19,500,000 as a gift from federal funds. The bill passed by the legislature carries the provision that 1¼ ct. of the 3½ ct. gas tax, received by the State Highway Commission, be pledged for the retirement of the loan. All told, when one buys a gallon of gasoline in Mississippi one is taxed 7 ct. a gallon. This is divided after collection as follows:

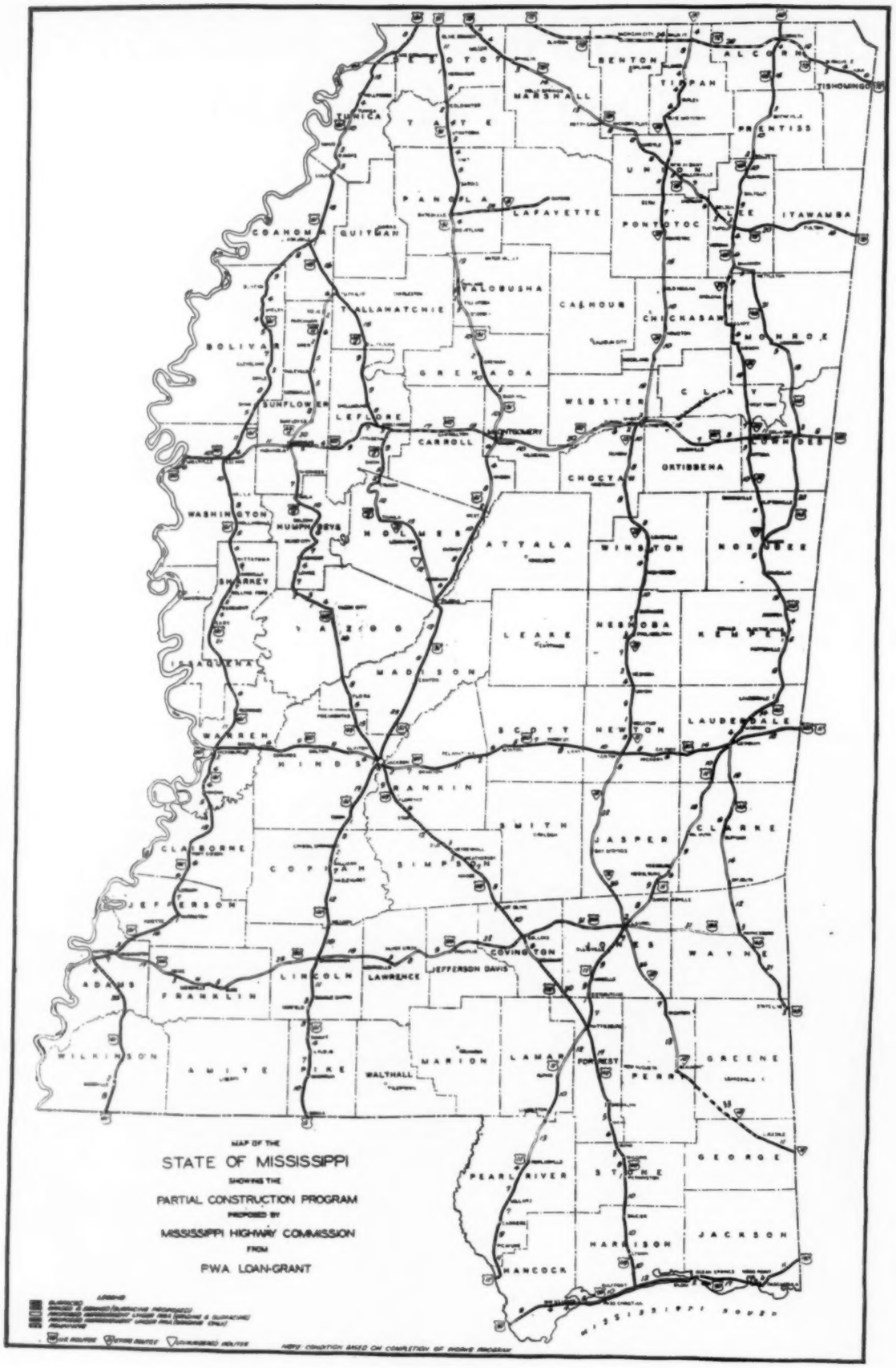
Federal Government .....1 cent
Counties .....2½ cents
State Highway Commission....3½ cents

It is estimated that a 1 ct. tax will return about $1,000,000. Hence a 1¼ ct. tax should amortize the loan in 20 years. That brings up the one big point in this program.

Money to be spent from a loan that takes 20 years to repay should build roads that will serve for 20 years is the policy of the Commission.

When the measure to float a loan was introduced in the legislature, a companion bill was passed immediately, which designated the highways to be constructed in two

This letting was heralded by Gov. White as a great day for Mississippi. Chairman Williams assured co-operation of the commission with contractors, and said they would discharge any project engineer treating a contractor harshly or unfairly. Commissioner Patterson said contractors' artisanship represents the last link in the long chain of effort to pull Mississippi out of the dust and mud.



Map Showing Work Proposed Under Priority System

categories: (1) a priority system, (2) a secondary system. All told there are about 6,100 miles in the state highway system. The priority roads amount to about 2,500 miles, of which approximately 1,900 are yet to be paved or graded, drained, and bridged. A short calculation will show that not over 1,400 miles of the 1,900 left can be surfaced with the funds available unless some low cost road work is constructed. This, of course, will require a change in policy and construction standards.

The present governor, Hugh White, was elected on a good roads declaration. Considerable political maneuvering was necessary to enact the bill. It was desired to have the highway commissioners appointive (they are now elective, with terms expiring January 1, 1937), however, Gov. White in public statements declared that the elective system was satisfactory so far as he was concerned but if it were made appointive he would sign the bill. The appointive system was desired so that no hitch might come to the consummation of the program or change in the policies of the commission. So a three-year appointive term for highway commissions was placed in the bill as passed. At the expiration of three years, the system previously (and now) in force becomes effective. Governor White is a business man who wanted to be governor of his State before he retired. He wanted his State to have a highway system that would invite travel into the State to its many points of beauty and historic interest. He set about to do it and is making progress.

Unfortunately, in past years, the highway commission had to struggle along on a small income, doing only maintenance work except for some small federal aid funds and emergency relief funds for construction. They were not prepared to meet a $42,500,000 program of which $38,000,000 must be under contract within about a year. No comprehensive traffic survey had been made nor had there been any State-wide materials survey made. Only 375 miles of graded road were ready to receive the surfacing.

Calculations quickly indicated that contracts would have to be let at the rate of $3,000,000 or more a month. Speed, pressure, and increase in personnel resulted and it is the writer's prediction that personnel must yet be considerably increased. The drafting room is operating with about 180 men on three 60-man shifts. The commission still has its problems but they are confident in their ability to "come through."

Other calculations have indicated, to the writer, that a gravel supply other than commercial plants as now operating with their present equipment will be required to supply the aggregate materials to maintain a condition of free competition. There are many local deposits in the State below Jackson. Only a few places contain deposits in the northern portion. A map shown herewith gives the names and locations of commercial plants. Another map, one which accompanied the request for a PWA loan, shows the work proposed to be done on the priority system. To start the work the State Bond Commission, on May 14, 1936, sold $5,000,000 of State notes bearing an interest rate of 4 per cent. A premium of $12,051 was paid for the issue. This figures out to about 3.97 per cent interest rate on the issue. These bonds, it will be noted are not supported by the full faith and credit of the State but by a pledged 1¼ ct. per gallon tax on gasoline.

The $5,000,000 now available added to the $4,500,000 federal aid makes $9,500,000 immediately available to pay construction costs.

In awarding contracts it is the intention of the Director to spot the projects over the State.

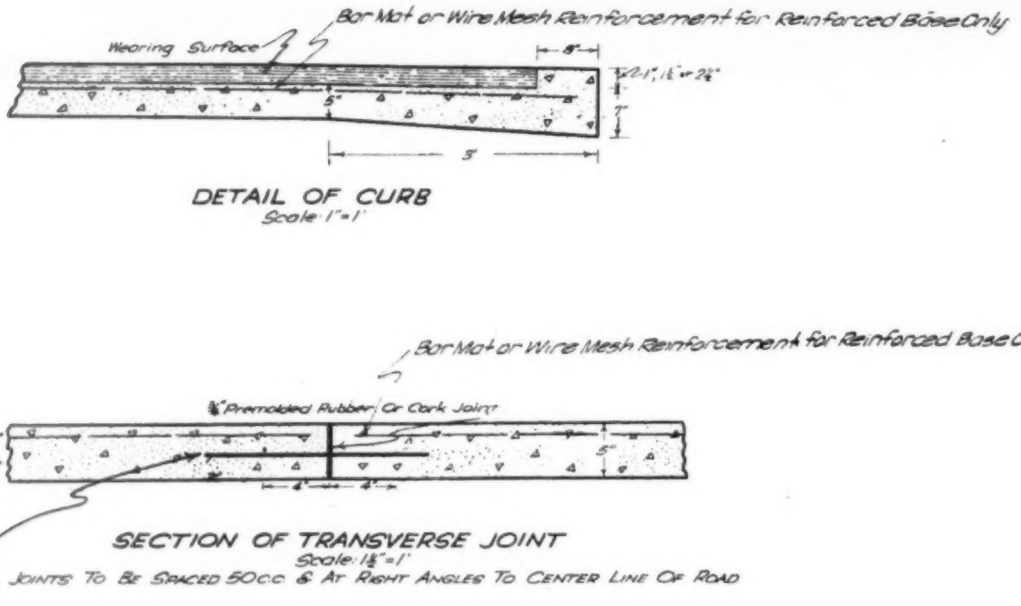
Cross Sections.—The highway law, as enacted, requires four types of paved surfaces as competitive types. While the law is fulfilled, in reality all but two of the sections are dummy sections, i.e., they are at a disad-

Opening the First Bid

Note stock of bids on table, each bundle representing one job and each envelope one bidder.

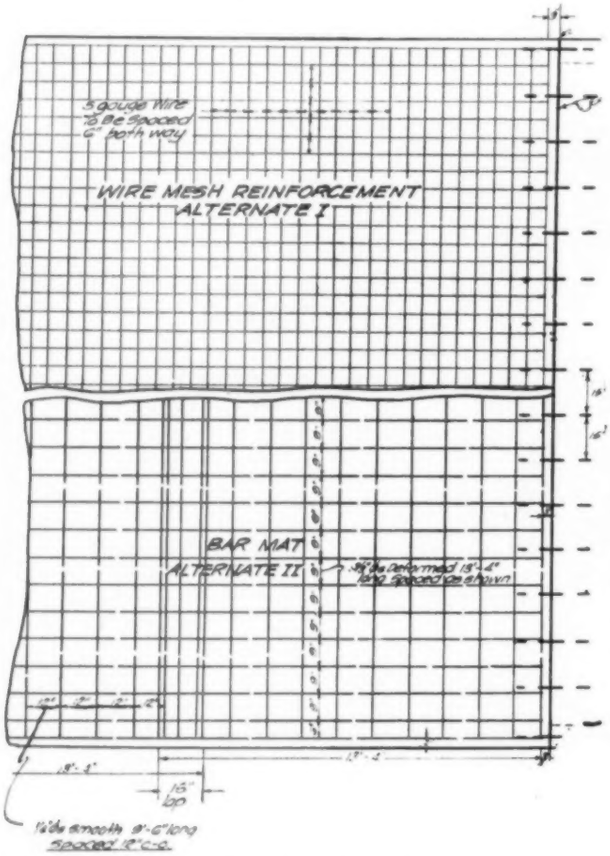
Front row—left to right: R. A. Harris, Chief Eng.; E. D. Kenna, Director; Hiram Patterson, Commissioner; Brown Williams, Chairman of Commission; Gov. Hugh L. White; Abe Linker, Commissioner.

This picture was taken in the ball room of the Robert E. Lee Hotel. As all the contractors could not get in, direct radio connection was supplied to each hotel room, and many got their returns there.

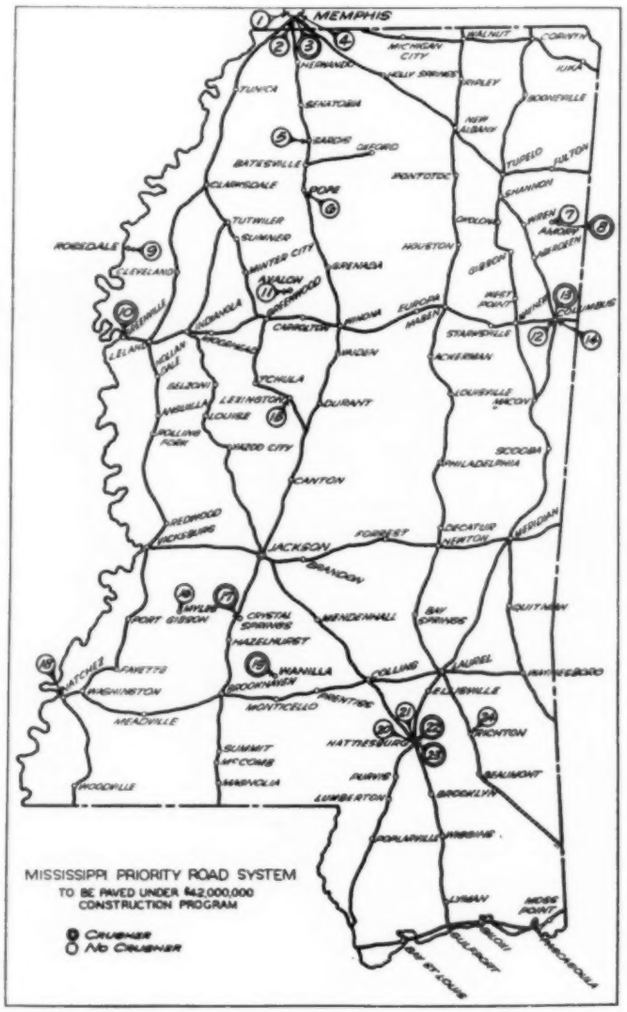

Bar Mat or Wire Mesh Reinforcement for Reinforced Base Only
Wearing Surface
DETAIL OF CURB
Scale: 1"=1'
Bar Mat or Wire Mesh Reinforcement for Reinforced Base Only
Premolded Rubber Or Cork Joint
SECTION OF TRANSVERSE JOINT
Scale: 1½"=1'
Smooth Dowel Bars Spaced 18" C.C. See St Std. PJ-2 For Details
JOINTS TO BE SPACED 50 C.C. & AT RIGHT ANGLES TO CENTER LINE OF ROAD

Curb and Joint Details, Group B-4

vantage in competitive bidding. Bituminous types can compete, when specified, only under most favorable conditions of aggregate supply. They are placed on a stabilized base. For example, group A-11 and B-4 would be specified on one project or A-12 and C-3 as com-


5 gauge Wire To Be Spaced 6" both way
WIRE MESH REINFORCEMENT ALTERNATE I
BAR MAT ALTERNATE II
½"ø Deformed 18'-4" long Spaced 18" C-C
½"ø smooth 9'-6" long Spaced 18" C-C

Reinforcement Plan of Portland Cement Concrete Base Course for Group B-4



Map Showing Location of Commercial Gravel Plants

petitive types on another. In some cases the State has obtained options on local aggregate pits. They are usually described in the specifications and may be transferred to the contractor upon his request. In listing projects for proposal the types of surfacing are designated by groups as follows:

Group A-11: 9-6-9 in. section portland cement concrete.

Group A-12: 7-5-7 in. section portland cement concrete.

Group B-4: Various asphalt surfaces on 7-5-7 concrete base with concrete curb.

Group C-3: 4 in. asphaltic concrete base with 1 in. or 1½ in. top on gravel or stabilized subgrade.

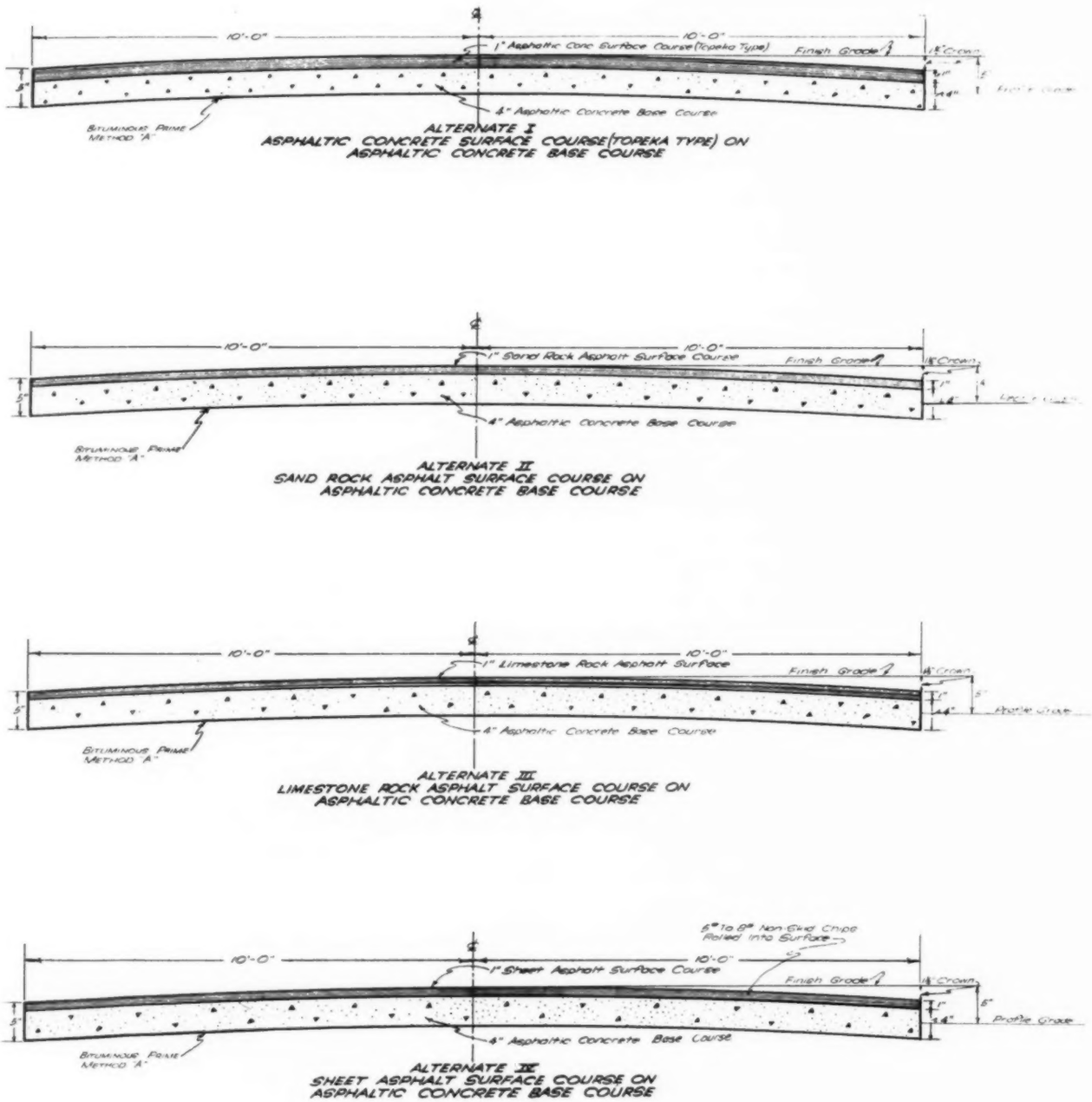
Group C-4: 2 in. sand asphalt surface on 3 in. sand asphalt base.

Group C-5: Rock asphalt seal coat on 2½ in. asphaltic road mix or plant mix—8 in. gravel subbase.

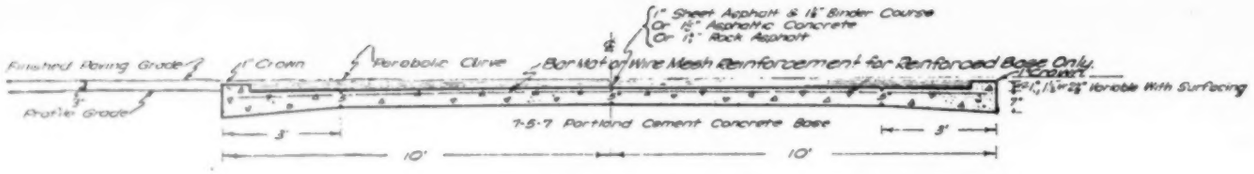
Group C-6: 4 in. sand asphalt base course with 1 in. of various asphaltic wearing surfaces.

Concrete Proportions.—Concrete is proportioned on a weight basis, approximately as follows:

For A class aggregate one (1) bag of cement to 207 lb. of fine aggregate and 342 lb. of coarse aggregate. The A class gravel runs from the No. 4 sieve to 1 in. size. Other classes of aggregate have slightly varying proportions.

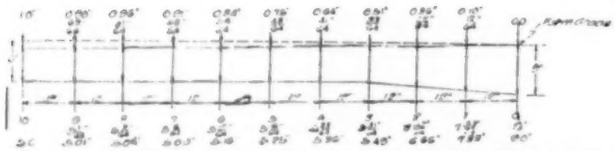

10'-0"
10'-0"
1" Asphaltic Conc Surface Course (Topeka Type)
Finish Grade
4" Asphaltic Concrete Base Course
Bituminous Prime Method "A"
ALTERNATE I
ASPHALTIC CONCRETE SURFACE COURSE (TOPEKA TYPE) ON ASPHALTIC CONCRETE BASE COURSE
1" Sand Rock Asphalt Surface Course
ALTERNATE II
SAND ROCK ASPHALT SURFACE COURSE ON ASPHALTIC CONCRETE BASE COURSE
1" Limestone Rock Asphalt Surface
ALTERNATE III
LIMESTONE ROCK ASPHALT SURFACE COURSE ON ASPHALTIC CONCRETE BASE COURSE
1" Sheet Asphalt Surface Course
ALTERNATE IV
SHEET ASPHALT SURFACE COURSE ON ASPHALTIC CONCRETE BASE COURSE

Pavement Sections—Group C-3



CROSS SECTION OF SHEET ASPHALT—ROCK ASPHALT OR ASPHALTIC CONCRETE WEARING SURFACE WITH CONCRETE BASE COURSE

Pavement Section for Group B-4

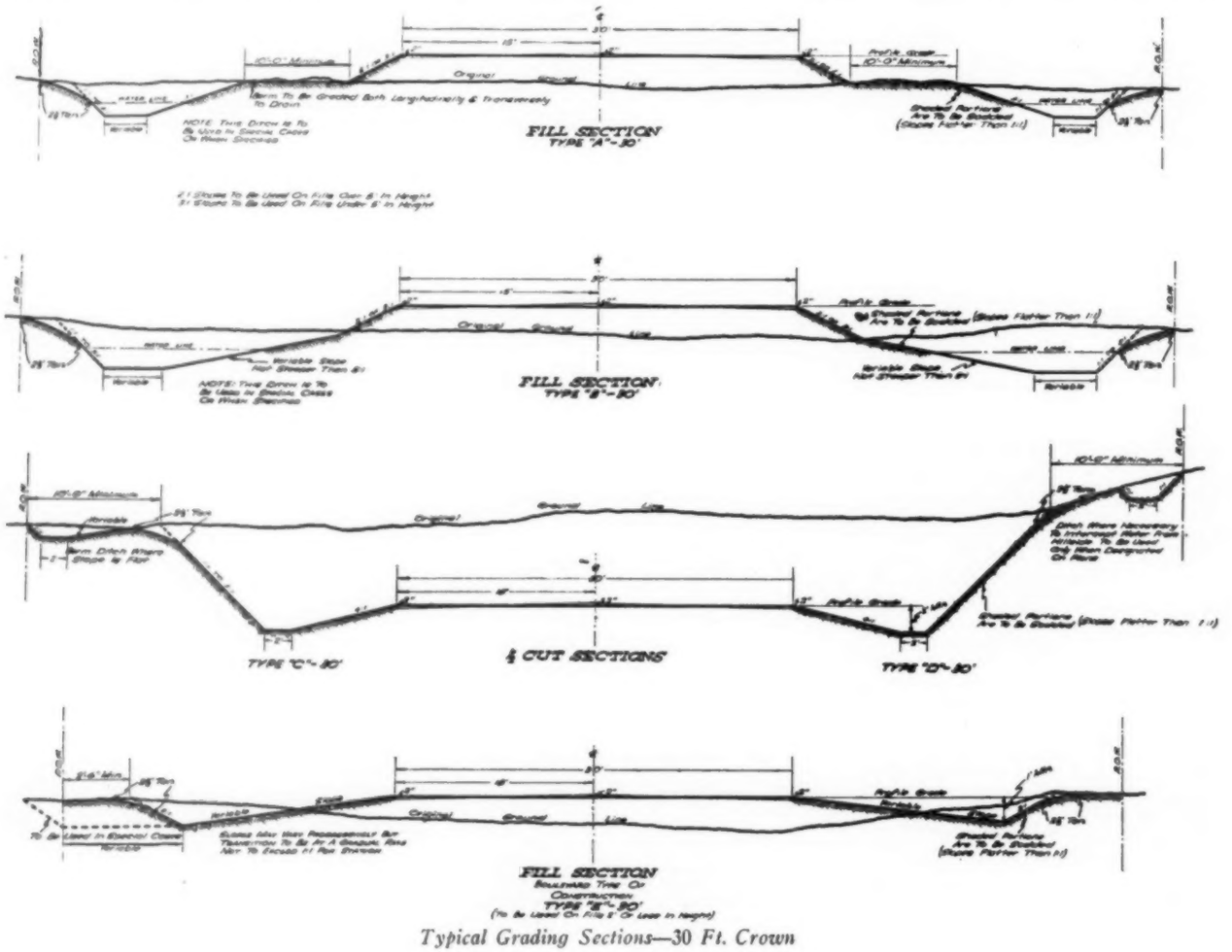


Ordinates for Setting Surfacer Screed and Scratch Template for 9-6-9-20 Ft. Pavement with 1-In. Crown

Concrete is proportioned on a weight basis rather than on a strength basis. For one cubic yard of concrete the cement factor is about 1.45 bbl. All materials must be tested and approved by the laboratory, Mr. H. O Thompson, Materials Engineer. If a new pit or new source of supply is opened it will require at least 30 days to get approval of the material.

Grading.—Standard sections have been adopted, one of which is shown herewith, for grading with 26, 28 and 30 ft. tops. Economy of funds is an important consideration at this time at the expense of highway safety. Bridges and culverts, however, will be long enough to permit widening the fill.

To state simply that grading averages 25,000 cu. yd. per mile is simply to guess at what the average of many miles has been. At present, dependent, of course, upon the individual project, dirt work has been going for 25 to 35 ct. a yard. Common labor must be taken from relief rolls in the locality. The agency requires 5 days' notice for furnishing men. Labor can work only 8 hours a day and not to exceed 130 hours per month. The rate for common labor is 22½ ct. an hour, medium class labor 35 ct. an hour, and skilled mechanics 65 ct. an hour. The highway law requires local labor to be used except for administration, executive or highly skilled work. Grading contractors, as well as others, cannot afford to maintain camps. It costs more to feed and house men than the contractor is permitted to charge for it. Men get to the job by their own means and return the same way. Due to the speed necessary for construction, compaction methods will be stressed for



Typical Grading Sections—30 Ft. Crown

solidifying fills. Many miles of hard surface will be placed on new fills.

Administrative Set-up.—The State is divided into three commissioners' districts. The north district is subdivided into two districts for constructive purposes. Each of the four construction districts is under the supervision of a district engineer. Another subdivision of the three into six districts is made for maintenance purposes; each commissioner's district being divided in two maintenance districts. A maintenance district engineer is in charge of each.

It is the policy of the State Highway Commission to have all details of construction and original surveys handled by the district engineers of the four construction districts. Only the preparation of plans, specifications, and proposals are handled at headquarters.

Personnel.—Following is a list of personnel of the highway department:

MISSISSIPPI STATE HIGHWAY COMMISSION

Brown Williams, Chairman.....Philadelphia
F. L. Linker, Commissioner.....Oxford
Hiram J. Patterson, Commissioner.....Monticello
E. D. Kenna, Director.....Jackson
J. B. Burns, Jr., Secretary.....Jackson

GENERAL OFFICE
Jackson, Miss.

R. A. Harris.....Chief Engineer
E. B. Cavallo.....Construction Engineer
Sam J. Dalton.....Maintenance Engineer
G. A. Draper.....Research Engineer
C. S. Hill.....Bridge Engineer
J. D. Monette.....Office Engineer
J. F. Fouville.....Engineer of Plans
W. W. Dunn.....Equipment Engineer
H. L. French.....Right-of-Way Engineer
I. W. Brown.....Location Engineer
H. O. Thompson.....Testing Engineer
J. M. Harmon.....Treating Engineer
M. B. Ellzey.....Chief Auditor

DISTRICT ENGINEERS

C. W. F. Harper, 1st District.....Jackson
J. D. Lewis, 2nd District.....Hattiesburg
T. C. Robbins, 3rd District.....Tupelo
C. E. Downing, 4th District.....Oxford

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Good Roads Aid Human Progress

THE desire for good roads and highways is not a new one. As soon as man discovered the wheel and its possibilities, immediately he yearned for good roads, and, step by step, secured them.

As civilization of the race progressed, man, with the newly found method of transportation, saw the necessity of changing conditions to suit the new discovery.

He realized the value of a better path for his wheel. That was really the birth of the good roads movement.

Little, however, is recorded in history concerning the early phases of development of the forerunners of our modern motor cars.

Historical records do reveal that as early as 2000 B. C. the streets of Babylon were paved, but the methods used have been lost in antiquity.

The Romans, under Caesar, never heard of gasoline-powered rock crushers; the Egyptians, of old, wasted much energy because they had no motor trucks to haul stones to their pyramids; and the Babylonians lacked concrete mixers. Yet history, strange as it may seem, recites the fact that the Romans stone paved their highways in such substantial manner they have withstood the wear of centuries and are found to have been the most solid road structures in any age.

History further speaks of a magnificent Egyptian road, built to assist in the construction of one of the world's great wonders—the Pyramid of Cheops.

The world is still puzzled to know how the ancients moved the immense stone slabs to the site of these great tombs, then piled them, tier on tier, to dizzy heights, marking the final resting places of their notable leaders.

Farther down the corridors of history, in America during pre-Revolutionary days, Indian trails provided the only means of travel for many years.

It is traditional lore that many of the streets of modern Boston were originally cow paths. Gradually the cow paths were improved and developed into post roads, streets, and highways. To this day the wanderings of the cows of Continental times are still to be noted in some of the tortuous street courses of New England's metropolis—with the difference they are now paved. That early desire brought good roads, and today the roads all over New England prove a delight to the traveler.

As the population moved inland from the Atlantic seaboard the Indian trails leading westward were widened for the use of ox-drawn and horse-drawn wagons. They could scarcely be called roads for they long remained in an intolerable condition. Rains and melting snows produced quagmires through which even the ox-drawn carts found difficulty in passing.

Necessity thus brought about the construction of a new type of road. By felling trees, dragging them to and placing them across the muddy pathways, then allowing the timber to settle and sink in the mud, the nation's pioneers produced a "corduroy" road. This method eliminated the ruts and deep mud, but produced a bumpy road surface. It was an improvement over the old type of road and was used in many sections of the East for many years.

The first attempt to build a highway of any considerable distance was made in 1806 when Congress appropriated funds and began building the National Pike or Cumberland Road. This stretch of highway ran from Washington, D. C., to St. Louis, Mo., a distance of 800 miles, and cost the Government $7,000,000. It was indeed a lasting achievement. In our own day it forms the eastern section of Trans-continental Highway No. 40, the northern route across Nevada.

There is, however, a vast difference between the old Cumberland Road and Highway No. 40. The desire for better roads has brought about this and many other changes.—*Nevada Highways and Parks.*

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Concrete Pavement Construction Costs New York State—1932-1935

The annual report of the New York State Superintendent of Public Works for the year 1935 gives the following average costs per mile of concrete pavement 20 ft. wide and 7½ in. thick:

1932	$20,431.93
1933	24,278.62
1934	25,795.66
1935	29,463.82

These are contract costs for pavement only, and do not include such items as grading, culverts, or drainage.

The report states that in 1932 highway construction costs reached the low point for a period of a great many years.

The high costs of 1935 were due to a considerable extent to labor conditions.

SAFE SPEEDS AND ROAD CAPACITY

By H. J. FIXMER,
Division Engineer, Board Local Improvements, Chicago, Ill.

INCREASED speeds on the highway, with the attendant accidents and damage, have caused wide discussion of the problem of safety. Engineers have made great advances in building safety into the roadway: By wider and smoother surfaces, safer curves, increased sight distances, standard marking, lighting, signals and grade separation. Engineers have produced reliable and efficient cars, with four wheel brakes, stronger bodies, powerful engines, economical of fuel, and other equipment. The third factor is the driver or operator of the car. The education and regulation of the driver is the field of government administration, and other civic agencies. In this, engineering advice can assist to the extent of educating the driver and officials as to the factors to be considered in securing more intelligent driving under various conditions and thereby assuring the road users a greater degree of safety.

The driver must know the distance required to stop at various speeds, under various road conditions, his dependable reaction time and braking efficiency of his car. He is interested in having the "other fellow" know this also.

Table I is a working safety table which can be adapted to the use of an individual driver. It is based on factors derived from various experiments and sources. Formulas are given to show derivation of tables and are of use in preparing similar tables.

Table II gives approximate or expected road capacity, or number of cars per lane of traffic.

Explanation of tables and comments are given to aid in applying the data given.

Factors to Be Known or Assumed

"D" = Distance required to stop from instant of application of brakes.

"S" = Speed in miles per hour. "S. R. T." = Seconds reaction time (of driver).

"f" = Friction factor of pavement surface.

"B" = Brake factor. The above table based on value of 30 (4-wheel brakes). For 2 wheel brakes value of B is 20 or increase values of D in 4A, 4B, 4C, 4D, 4E, one half, or 50 per cent.

Since, $D = \frac{S^2}{Bf} + (1.46 \times S \times \text{S.R.T.})$ (Formula 1) multiply Col. 2 by S.R.T. and add to figure in Col. 4 (on same horizontal (or speed) line).

Example—Speed = 30; f = 0.4; B = 30; S.R.T. = 2.0.

On horizontal line for 30 miles per hour, trace to Col. 2 and read 43.8. But S.R.T. = 2.00, hence feet moved = 43.8 × 2 = 87.6. To this add 75.0 in Col. 4C. Total value of D — 162.6 ft.

For 2 wheel brakes, increase value 75 by 50 per cent = 112.5. Add 87.6. Total = 200.1 ft.

Night driving, on poorly lighted road, to be reduced to head light range. Substitute head light range for "D" in Formula 1, and solve for S.

TABLE I.—WORKING SAFETY TABLE FOR AUTO TRAFFIC

1	2	3	4					5	6
			D = Distance required to stop, from time brakes are applied. 4-Wheel Brakes. B = 30					Individual S.R.T. =	Total Distance
Speed in Miles per Hour	Feet Moved in One Second SRT = 1.0	Feet Moved in ½ Second SRT = 0.5	Dangerous to Occupant A f = 0.8	Dry No Skid B f = 0.6	Rain Wet C f = 0.4	Mud Snow D f = 0.2	Ice E f = 0.1	Col. 2 Times SRT of Driver by Test	Required to Stop Safely Against Cross Traffic or Obstructions
5	7.3	3.7	1.05	1.4	2.1	4.15	8.3	.....	.....
10	14.6	7.3	4.2	5.6	8.3	16.6	33.3	.....	.....
15	21.9	11.0	9.4	12.5	18.8	37.5	75.0	.....	.....
18	26.3	13.2	13.5	18.0	27.0	54.	108.0	.....	.....
20	29.2	14.6	16.6	22.2	33.3	66.6	133.3	.....	.....
25	36.5	18.3	26.0	34.7	52.1	104.1	208.2	.....	.....
30	43.8	21.9	37.5	50.0	75.0	150.	300.	.....	.....
40	58.4	29.2	66.6	88.8	133.3	266.6	533.	.....	.....
50	73.0	36.5	104.	139.	208.	416.	832.	.....	.....
60	87.6	43.8	150.	200.	300.	600.	1200.	.....	.....
80	116.8	58.4	267.	355.	533.	1067.	2133.	.....	.....
100	146.0	73.0	417.	555.	833.	1666.	3333.	.....	.....
Speed = S	ft. = 1.46S	ft. = .73S	Max. Value $D = \frac{S^2}{24} = .042S^2$	$D = \frac{S^2}{18} = .056S^2$	$D = \frac{S^2}{12} = .083S^2$	$D = \frac{S^2}{6} = .167S^2$	$D = \frac{S^2}{3} = .333S^2$	Above to Be Filled Out By Driver	Add Col. 5 to proper Sub. Col. Under Col. 4

Figures in column 4 above line are generally safe stopping distance for City streets with frequent crossings.

TABLE II.—ROAD CAPACITY

Number of cars per hour, per mile, per lane, based on Formulas 3 and 2 and values as noted.

S = Speed in Miles Per Hr.	SRT = .5 4 Whl. Brakes B = 30				SRT = 1.0 B = 30			SRT = 2.0 B = 30			SRT = 1.0 B = 20	
	f = .6	f = .4	f = .2	f = .1	f = .6	f = .4	f = .2	f = .6	f = .4	f = .2	f = .6	f = .2
5	1260	1217	1110	948	1073	1045	964	825	808	763	1040	895
10	1820	1671	1323	930	1460	1352	1118	1040	987	855	1357	950
15	2000	1715	1232	780	1568	1400	1053	1094	1010	816	1400	840
18	2010	1695	....	....	1571	....	....	1098	....	....	....	....
20	1992	1655	1090	645	1553	1348	953	1090	983	750	1347	727
25	1922	1546	969	....	1519	....	....	....	....	....	....	....
30	1815	1407	846	443	1437	1178	757	1028	888	625	1178	556
40	1567	1186	680	370	1287	1120	621	950	795	530	1019	445
50	1370	1015	567	....	....	....	....	....	....	....	....	....
60	1212	880	482	245	1038	787	452	805	647	400	787	315

Road Capacity

On lane moving traffic—allow 10 ft. width.

Each lane parking (non-moving) traffic—allow average = 8 ft. width.

Width of roadway = moving lanes × 10 + parking lanes × 8.

Let E = distance apart in feet of cars on lane.

V = average length of vehicles. Average value of V = 16.

S. R. T. = seconds reaction time (time of driver between perception and action of brakes).

$$E = \frac{S^2}{Bf} + (1.46S \times S.\ R.\ T.) \quad \ldots\ldots (2)$$

S = Speed in miles per hour.

B = Brake factor.

f = Roadway friction factor.

C = Cars per hour per lane per mile.

$$C = \frac{5280 \times S}{E + V} \quad \ldots\ldots (3)$$

In a train of cars (no distance between) using value of E = 0.V = 16′, then,

$$D = \frac{5280 \times S}{16} = 330\ S. \quad \ldots\ldots (4)$$

The above is a theoretical maximum, with no space between cars, no S. R. T., uniform speed and uniform action of brakes.

Refer to safety table for auto traffic for values of B and f and assume proper value of S and S. R. T.

Explanation of Tables and Comments

Table I, "Working Safety Table for Auto Traffic" is based on the factors used in the original "Safety Table for Auto Traffic."

This table applies to vehicles equipped with good 4-wheel brakes and gives values for various pavement surfaces.

Col. 1 tabulates the speed in miles per hour.

Col. 2 gives the distance in feet moved in one second for the corresponding speed. This distance is identical with one second reaction time. (S. R. T.)

Col. 3 gives the distance in feet moved in one-half second for the corresponding speed. (.5 S. R. T.)

Col. 4 gives distance required to stop from time brakes are applied. This column has five sub-columns for different friction factors depending on condition of pavement surface.

Sub-Col. A gives the minimum distance. This "rate of stopping" is dangerous to the car occupant, or at least highly uncomfortable. This is the rate used by the fellow who "can stop on a dime."

Sub-Col. B gives the safe minimum distance on a smooth, dry pavement.

Sub-Col. C gives the general minimum distance on a wet surface.

Sub-Col. D gives the minimum for a surface covered with snow, mud and oil.

Sub-Col. E gives the extreme for ice covered surface.

Col. 5 is to be filled in by the driver based on his assumed or tested reaction time. The figures in Col. 2 are to be multiplied by the individuals S. R. T. and placed in Col. 5 on the horizontal line corresponding to the speed and values in Col. 2.

Col. 6 gives total distance, adding corresponding figures of Col. 5 to those of Sub-Col. B, C, D or E of Col. 4.

For two-wheel brakes increase distance in Col. 4 by 50 per cent (one and one-half times).

Seconds Reaction Time varies with the driver and conditions. An alert driver in heavy traffic should have a time of one-half second. One second might be a fair average. On a light traffic highway his reaction time might increase to 5 or even 10 seconds.

Table II (Road Capacity) is based on the formulas used in Table I. This table gives Number of Vehicles per hour per mile per lane, for Seconds Reaction Time of .5, 1.0 and 2.0 and surface friction factors of .6, .4, .2 and .1 (See Col. 4, Table I).

The maximum number is underscored.

These figures assume that certain variables are constant. All cars have equal 4-wheel brakes; all drivers have an equal S. R. T. and the surface conditions prevail uniformly. In practice this ideal condition does not obtain. However, the figures have value in showing the effect of poor road conditions, slow speed, poor brakes and high S. R. T. Fifteen to twenty miles per hour is the speed accommodating the greatest number of vehicles, BUT these speeds depend on uniformity, seldom attained.

The value "E" in Formula 2 applies to surface driving where cross drives or roads are frequent. On a super highway with complete grade separation (no cross traffic) a modification of Formula 3 can be made, by substituting an assumed or "calculated" value for "E." If "E" is taken to be 24 feet, then

Formula (3) becomes $C = \frac{5280\ S}{24 + 16} = 132\ S.$ . . (4)

Thus, the volume would vary directly with the speed (S).

But, "Safety" = $\frac{\text{"Hazard"}}{\text{"Speed"}}$. Thus, with a given

"Hazard" an increase of "Speed" will give a lower "Safety" value.

Since "hazard" increases with "speed," a tentative formula for maximum "super highway" traffic might take this form:

$$C = \frac{5280\ S}{RS + 16} \quad \ldots\ldots\ldots (5).$$ R taken as 1.0 to 2.0.

Where traffic is of mixed speeds, capacity may be reduced 50 per cent to 80 per cent of the values given in Table 2, due to improper assumption of "S."

The practice of marking traffic lanes with the minimum and maximum speed as, "15-20" or "30-40" tends to increase road capacity.

Uniformity in speed, S. R. T., brake equipment, and road condition is the ideal to reach maximum use and safety.

Highways properly built and maintained as to surface with proper lighting and marking is one factor. The inspection of brakes and cars is another factor. The examination and regulation of the driver is the most important factor. Education, wise regulation and experience are important in achieving a safer and more efficient use of the highway.

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Road Drainage Experiences in Ontario County

EXPERIENCES in Peterborough County, Ontario, with certain drainage problems were described by A. E. Chalmers, County Engineer, in the recent Ontario Conference on Road Construction. In considering the information he gives it should be borne in mind that the type of country in which the experiments were carried out is a glacial drift, varying from ordinary gravel to fine silt with stones and boulders. We quote from his paper as follows:

Frost Boils.—Some three years ago, in the treatment of frost boils, I came to certain definite conclusions about frost and its action on gravel roads:

1. Moisture present in the road, freezes, commencing at the surface and freezing downward as the moisture laden soil reaches the freezing point.

2. On freezing, the soil and road materials are bulked, due to expansion of water on freezing.

3. The frozen roadbed thaws as its temperature rises above the freezing point. This thawing commences at the surface and moves downward.

4. The expanded road material will readily absorb more water, if rain falls at this time, and all voids in the thawed layer of roadbed may become filled with water, so that the internal friction of the soil particles is lost and there is every possibility of the road becoming impassable.

When there is no frost present in the roadbed, it may be subjected to considerable rainfall without causing much damage. This is because the soil is more dense and the small proportion of rainfall which does penetrate will continue downward and approach the ground water level.

The problem consists: (1) of preventing excess moisture entering a roadbed, and (2) after thawing commences, attempting to remove the excess moisture between the surface of the road and the top of the frozen layer.

Frost Boil Treatment by Blasting.—For the purpose of this discussion, the second item only will be dealt with and certain procedure related which has been used in Peterborough County and from which excellent results have been obtained. This excess water above the frozen layer of soil cannot soak away into the ground because of the impervious layer of frozen soil which is still below it. A certain amount of evaporation will take place on the surface but in some sections the top crust of gravel breaks and cracks and soon the traveling public will say that "the bottom has gone right out of the road."

Actually it is the solid layer of frozen material which remains, that causes this condition. To overcome this I felt that if this frozen layer could be broken or cracked the excess water could soak through to the dry soil below the frost level. For this purpose we have used explosives. A heavy bar having a diameter greater than a stick of dynamite is driven down to about the bottom of the frost level. From ¾ to 1 stick of dynamite or Blastol is then put down in this hole, tamped and exploded. The charge breaks the frost layer and usually blows a crater up through the road bed. Into this, coarse gravel and stones are placed and covered over with road gravel. The excess water soaks into the ground and the road becomes stable once more. A single frost boil will usually disappear in 24 hours. For an extended break-up, charges from 10 to 20 ft. apart have been tried with the same results. It has been found much easier to carry out this work before the road becomes impassable. In this way it is a prevention as well as a cure.

Vertical Drainage.—From the experiences related above, I believe that some consideration might be given to what I shall call "Vertical Drainage." Instead of underdrains which carry moisture through the shoulder of the road to the ditch, might it not be feasible to lead moisture downward and assist nature in carrying out the same scheme of things as takes place after any rainstorm in the summer. I have in mind a series of vertical drains connected by a horizontal collecting drain down the center of the road. In certain soils the vertical drains might be dug with a post hole auger or a machine such as is used by digging holes for telephone poles. The vertical drain should be carried into the soil below frost level a distance sufficient to bring the porous drain material in contact with sufficient soil to absorb any water which may reach it.

The vertical drain would necessarily have to remain porous and be able to pass moisture downward after several years of service. Perforated metal pipe surrounded by coarse sand or gravel and capped on top might be satisfactory. The horizontal drains should have porous material in them right to the surface, so that there is a possible outlet for water as soon as it is present in the surface of the road.

These suggestions may seem quite radical and may not be satisfactory for certain types of soil, but we have had such excellent results in the treatment of frost boils that we see no reason why the principle could not be applied to under drainage. It is of course not feasible where the normal ground water level is at such a height that the road bed is unstable. This type of underdrain has not been tried out in Peterborough County, as we have done very little underdrainage work of any kind. However, I intend to try it at the first opportunity. In future, blasting operations for treating frost boils, different types of vertical drains may be used, and records kept of conditions at that point.

Construction View of Paving Central St., Evanston, Ill. Excavation and Form Setting Was Kept Ahead of the Mixer.

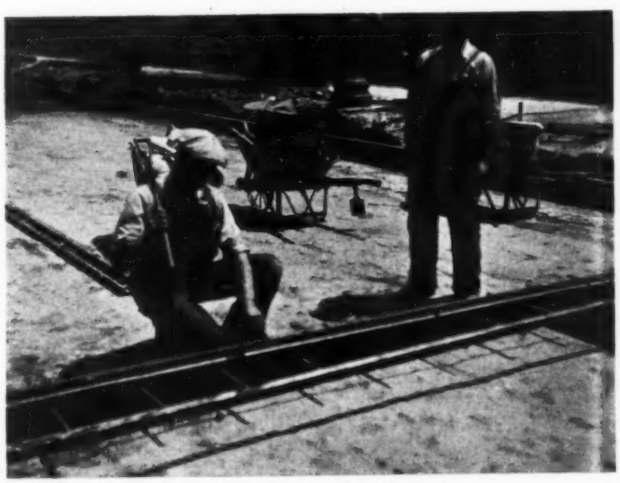
GOOD ORGANIZATION FEATURES OF STREET CONSTRUCTION PROJECT

GOOD organization for small street contracts is always a problem for the road builder. In constructing Central Street, Evanston, Ill., the Midwest Construction Co., of Niles Center, Ill., has demonstrated efficient production together with quality construction.

The west end of Central Street has been the center of a rapidly growing area in this suburban city. As the area filled with homes, Central Street was called on to carry heavy increases in local traffic in addition to the through traffic. The local business section grew with the community and the street, which had been adequate when built, became clogged, rough and dangerous.

Evanston's one-line street railway added further to the congestion on Central Street. As the city grew, bus lines were used to supplement the street car system where it did not serve. Finally it was decided to abandon the street car line in favor of buses, and to rebuild the old streets, giving them a modern surface with flat crowns, and large radii curbs.

The work on Central Street just completed is the second project in this program. The first work was on Chicago Ave. through a highly developed business district in the south part of the city.



All Accessories for Installing Joints Were Kept in Three Wheelbarrows Which Were Wheeled Along as the Work Progressed.

The present contract called for 21,000 sq. yd. of 10:8:10 concrete, joining West Railroad, a main north and south thoroughfare, with Crawford Ave., the next important through route.

The new pavement is 40 ft. wide the full length of the improvement, which required widening the street 4 ft. through the residential part of the improvement. While the street was not widened through the business section, removing the car tracks, taking out the high crown and providing a true even surface has added much to the effective width of the street and the safety of travel upon it.

Work included in the project consisted of removing car tracks and old macadam pavement, shifting street light poles and traffic signs, taking down trolley wires, and installing underground facilities. Broken stone removed from the street is to be used to pave gravel and dirt streets within the ward.

Half of the street was torn out to permit paving to get started. The pavement was placed in two 20-ft. lanes. A crew of 15 men was used to prepare the subgrade for paving, after the old paving was torn up. Their equipment consisted of a 3-ton roller, two subgrade cutters, a tractor and a light power grader. This crew completed the subgrade and set forms, including all special fitting at intersections and setting of man holes. These men were always one day ahead of the mixer.

They were followed by 4 men who set the joints, assisted by a fifth, who assembled them. Truscon air cushion expansion joints were used. Their accessories were carried in three wheel barrows. They were followed by one man who oiled forms, and clamped a metal template to the inside form to make a grooved inner joint.

Aggregates were proportioned at a plant several blocks from the job, and cement was added from a supply maintained nearby. Deliveries to the mixer were made with Ford trucks.

Everybody Worked Efficiently

A new Rex paver was used on the job. There were two mixer operators, 5 men to spread the concrete and one man on the finishing machine. Hand finishing was kept to a minimum. It consisted of floating with long-handled floats with belting as the final finish. This work was done by three men. A fourth man finished joints and edges.

Wet burlap was used for curing the first day, followed by an application of calcium chloride. Three men took care of curing and removing forms.

The project is being built by the Cook County Highway Department with PWA funds and revenue from the city's and county's share of the gas tax. Labor was obtained from relief rolls. Each man is limited to an 8-hour day.

Actual work on the project started on April 19 and the last concrete was placed on May 23.

The amount of the contract was $87,162.

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Why New York State Had No Highway Contract Performance Failure in 1934 and 1935

In 1935 no highway contract was cancelled due to failure to perform on the part of the contractor, a condition which equaled that of 1934. I again repeat that this is due, in large measure, to laws which were passed by the 1934 Lewislature making it mandatory for the department to hold the bidding check of the contractor until 10% of his work is completed when a bond is furnished and 15% when a bond is dispensed with. Many contractors in former years, when the market for materials was steadily falling, were able to secure bidding checks and even temporary qualifying loans from banks. Banks are no longer willing to make such loans unless they are assured of the efficiency and good standing of the contractors who are applying for them. This law has almost, if not quite, eliminated the "fly-by-night" contractor who has little or nothing to lose and everything to gain by being awarded a contract. Bonding concerns, furthermore, will no longer write bonds for contractors who are not financially stable because we are now in a rising market. In a falling market, there is little risk in writing surety bonds because, if a contract is cancelled for non-performance, it can almost invariably be relet at a lesser price than the original bid, or if the price is a little greater, the 10% retained by the department is usually sufficient to cover the added cost.—*From the Annual Report of the New York State Superintendent of Public Works for the Year* 1935.

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Adjustment of Utilities in Connection with Railroad Grade Separation Work

So many inquiries have been received by the U. S. Bureau of Public Roads regarding the availability of Works Program grade crossing funds for the adjustment of public and private utilities in connection with grade crossing work that the following statement of general policy has just been issued by the Bureau:

Any facilities owned by public or private utilities on railroad rights of way or private rights of way, which have to be moved or changed to meet the new conditions created by railroad grade separation work, may be moved or changed within such rights of way and the actual costs thereof paid from Works Program grade crossing funds. This applies to water supply lines, gas mains, pipe lines, sewers, electric transmission power lines, telephone and telegraph lines, etc., on railroad rights of way, but not owned by the carrier and to such facilities occupying private rights of way in fee or by lease or easement. Such adjustments may be made by the owning company, or when the facilities occupy railroad rights of way the alterations may be accomplished by the railroad company with its own forces, as may be agreed between the affected companies. The principles outlined in Works Program General Memorandum No. 6, dated August 15, 1935, shall be applicable to reimbursement for such adjustments. No part of the cost of acquisition of private rights of way for the reestablishment of public or private utilities may be paid from federal funds.

Where public or private utilities occupy public rights of way by reason of franchise grants and their facilities have to be moved or changed to meet the new conditions created by railroad grade separation work the Bureau permits the State highway departments to determine to what extent reimbursements from Works Program grade crossing funds will be asked for such adjustments in accordance with the principles outlined in Works Program General Memorandum No. 6, dated August 15, 1935. The franchise provisions of the utilities differ to such an extent that our policy with respect to moving or changing facilities of public or private utilities occupying public rights of way is to be guided by a State's determination as to whether the adjustments are such as were contemplated in the franchise and are enforceable against the utility.

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Would You Live Content?

True, it is dangerous to become satisfied with accomplishments, but even road builders cannot be blamed for seeking contentment in life. Here is a set of fundamental requirements for contentment as stated by Goethe, the German philosopher:

Health enough to make work a pleasure. Wealth enough to support your needs. Strength to battle with difficulties and overcome them. Grace enough to confess your sins and forsake them. Patience enough to toil until some good is accomplished. Charity enough to see some good in your neighbor. Love enough to move you to be useful and helpful to others. Faith enough to make real the things of God. Hope enough to remove all anxious fears concerning the future.

TRAFFIC SURVEYS FOR TOLL BRIDGES

By GEORGE HARTLEY

Of Robinson & Steinman, Consulting Engineers, New York

THE trend of traffic over toll bridges and highways is constantly changing due to the many factors affecting motor vehicle travel, principally changes in those factors which are used as a basis for a correlation analysis of traffic, such as motor vehicle registrations and gasoline consumption statistics. The extent and range of this variation have been computed for a number of toll bridges where traffic over a period of years was known and the results obtained indicate an extremely high degree of positive correlation between either one or both of these factors. Toll bridge operators are always interested in methods for estimating future traffic or earnings, the methods shown in this article are the result of extended study and include the methods developed by leading authorities in this field. The accuracy with which forecasts of future traffic can be made is shown to depend almost entirely upon the accuracy of forecasts of registration and gasoline consumption statistics.

Assumptions Regarding Traffic Characteristics.—In making any analysis of traffic flow, certain assumptions with regard to various characteristics of traffic must be made, essentially: traffic represents some function of motor vehicle registration, population, gasoline consumption, industrial activity and distance traveled. Some method whereby these factors may be equated to traffic must be derived. From the construction of numerous plots of traffic and its relation to population, registration and gasoline consumption, it is evident that traffic can be expressed as an exponential function of one of these factors, that which approaches actual traffic can only be determined by observation and study. The census of population is made at periodic intervals of ten years and its usefulness is therefore limited. Registration statistics are available every year usually classified by states, although some states have inaugurated a new classification by counties, a valuable aid to the traffic analyst. Registration and population are very closely associated and each may be expressed in terms of the other, that is, population studies are available every ten years, but by relating Registration in Census years to Population, estimates of population in other than census years may be made, and as population and registration are proportional to each other it will not be necessary to consider an analysis by the use of Population Statistics. Until recently registration statistics were used almost exclusively, but with the advent of the present economic conditions registration fell off and traffic increased. It was therefore necessary to correlate traffic with some other factor, as population and registration are very closely associated there would be no advantage in using population as an index, therefore gasoline consumption was used as a basis for calculations and the equation relating traffic and these factors takes the form

$$T = kR^n \quad \ldots\ldots\ldots [1]$$

where T represents the traffic, R the population, registration or gasoline consumption, k being a constant, n being an unknown exponent. By ploting this equation on logarithmic paper as

$$\text{Log } T = \text{Log } k + n \text{ Log } R \quad \ldots\ldots [2]$$

the value of the slope n may be obtained without considering the constant k, as the plot of this equation on logarithmic paper is a straight line, it is possible by extending the known data to cover an extensive range and provide a graphical method for estimating when the gasoline consumption or other factor is known.

Analysis of Traffic for Two Bridges.—An analysis of traffic over the Douglas St. toll bridge between Omaha, Neb., and Council Bluffs, Ia., show that traffic and gasoline consumption for an area having a radius of 50 miles with the bridge as a center, has an extremely high degree of positive correlation with gasoline consumption. A comparison of results obtained when using gasoline consumption statistics and registration statistics are shown in Table 1, in which n is the exponent in formula (1).

In Table I a constant value of n would indicate a perfect degree of positive correlation, because as the deviation from a constant increase the degree of correlation decreases. In Table I the extremely small deviation of n by the use of gasoline consumption indicates a high degree of positive correlation not obtainable by the use of registration statistics. Similar values were computed for the Philadelphia-Camden Bridge and the Tacony-Palmyra Bridge; the results obtained are tabulated in Table II.

The degree of accuracy and the determination of the proper factor to use at any one location can be determined from an analysis of the relation of the value n to actual traffic. For the Philadelphia-Camden Bridge a maximum deviation from the mean of 14.8 per cent was obtained when using gasoline consumption, whereas the maximum deviation obtained when using registration statistics was only 9.75 per cent. For the Tacony Palmyra Bridge the maximum deviation due to gasoline consumption was 8.4 per cent and when using registration statistics 11.43 per cent. Then in making an analysis of traffic on the Philadelphia Camden Bridge by this method greater accuracy would be obtained through the use of registration statistics, while on the Tacony

TABLE I

Year	n based on Registration	n based on Gasoline Consumption
1926	1.231	0.822
1927	1.242	0.823
1928	1.256	0.286
1929	1.267	0.285
1930	1.278	0.830
1931	1.278	0.825
1932	1.248	0.822
1933	1.249	0.824

TABLE II

	Philadelphia-Camden		Tacony-Palmyra	
	n	n	n	n
Year	Registration	Gasoline	Registration	Gasoline
1927	1.182	0.814	.....	.....
1928	1.189	0.815	.....	.....
1930	1.198	0.817	1.035	0.707
1931	1.198	0.819	1.054	0.714
1932	1.190	0.814	1.049	0.709
1933	1.187	0.800	1.042	0.704
1934	1.185	0.797	.....	.....

Palmyra Bridge it would be advisable to use gasoline consumption statistics.

Unless the deviation of the value n from the mean is very large it is advisable at all times to use gasoline consumption statistics as a basis for computations when making estimates of the volume of future traffic, as gasoline consumption does not have the erratic increases and decreases common to registration statistics from year to year.

By combining registration and gasoline consumption when the deviation of n for each of these is small, or equal, and by the use of proper weights when required, will result in values having extremely small deviations from the computed mean.

Gasoline Consumption as Traffic Index—Public authorities also recognize the increasing importance of gasoline consumption as an index of traffic as evidenced in the Bureau of Public Roads survey of eleven western states in which charts showing the relation of traffic, registration and gasoline consumption for the states of California and Oregon show that traffic is directly proportional to the gasoline trend line and that traffic has increased at a much greater rate than registration. The state highway department for the state of Connecticut also recognizes the importance of gasoline consumption, for in its survey of 1931 it developed the following formula which takes into consideration both the effect of gasoline consumption and registration:

$$X = 0.433R + 0.367G \ldots [3]$$

in which:

R=Registration at the time traffic is desired.

G = Gasoline consumption at the time traffic is desired.

X = Required average daily state-wide traffic for the same period.

Many other methods have been developed representing considerable study upon the part of the authorities originating the method, as for example, the New York Regional plan and the Boston Planning Commission developed methods which are essentially the same, and both require considerable time and extensive analysis of traffic at the traffic station. The City Planning Board, Boston, Mass., used the following formula:

$$T = \frac{k D^2}{R_1 R_2} \ldots [4]$$

where

R_1 and R_2 represent the respective motor vehicle registration of any two traffic districts, D represents the distance in miles between the two traffic districts.

"It was found in general that traffic between any two pairs of traffic districts varies directly as the product of the motor vehicle registrations of the districts and inversely as the square of the distance between them."

Detemining Effective Radius—A principle of Physics developed by Sir Isaac Newton and known as "Newton's Law of Universal Attraction" in which it is stated "Any two bodies in the universe attract each other with a force which is directly proportional to the product of the masses and inversely proportional to the square of the distance between them." In making use of this principle in the solution of traffic problems the relation of the quantities in the problem under consideration to the scientific principle must be clearly shown. It is assumed that the motor vehicle registration of two areas may be likened to two masses, the traffic going from one area to the other equivalent to the attraction of the two masses, and the form of the equation being:

$$T = G R_1 R_2 / D^2 \ldots [5]$$

T = Traffic due to the two areas under consideration

R_1R_2=the motor vehicle registration of the two areas

D = the distance between the two areas

G = a constant

which may be stated, the traffic between any two areas of registration is directly proportional to the product of the registrations and inversely proportional to the square of the highway distance between the two areas of registration. Many areas contribute to the traffic in any one area and all areas contributing traffic should be included. Theoretically this means that every area having a registration of motor vehicles and a highway connection to the area under consideration would have to be included in the analysis. Considering all of these areas would make any study from a practical standpoint impossible. From statistics compiled by the Bureau of Public Roads, it has been shown that motor vehicle travel is composed mainly of local traffic. Then in considering a practical condition for making an estimate of future traffic based on this method, the area in which traffic is desired is used as a center and only those areas within an effective radius (that radius within which almost all travel exists) are assumed to contribute traffic. The effective radius for any location should be determined by actual observation at the traffic count station. In most instances unless counts are being made for a long period of time this is impossible and observations based on a short time count might be misleading. When conditions of this nature arise the tabulation given in Table III, which is a tabulation of the distance traveled by motor vehicles in various parts of the United States, will be of material assistance in making an approximate determination of the effective radius. As a check on the final effective radius, it is well to bear in mind that where the motor vehicle density is small motor vehicles will travel greater distances than in areas having a high motor vehicle density. On highways carrying considerable through traffic special study of the traffic will be necessary.

TABLE III. DISTRIBUTION OF PASSENGER CAR SERVICE BY LENGTH OF TRIP

Length of Trip Miles	Conn. Pct.	Vt. Pct.	Penna. Pct.	Ohio Pct.	Average Eleven Western States Pct.
0 — 9		29.8	22.3	27.9	
	55.7				15.0
10 — 19		16.1	22.0	22.8	
20 — 29		6.9	11.2	9.7	
	16.3				21.0
30 — 39		5.0	6.9	5.7	
40 — 49		3.8	3.8	3.6	
	9.2				15.0
50 — 59		2.4	4.9	2.9	
60 — 69		1.9	3.0	3.1	
	5.0				9.7
70 — 79		1.8	2.0	1.7	
80 — 89		1.5	2.0	1.3	
	3.6				5.2
90 — 99		1.4	1.9	1.1	
100 — 149	4.3	5.3	5.9	5.1	11.1
150 — 199	1.7	4.0	3.0	3.2	6.0
200 — 299	2.7	8.4	3.5	3.5	10.7
300 etc.	1.5	11.7	7.6	8.4	6.3

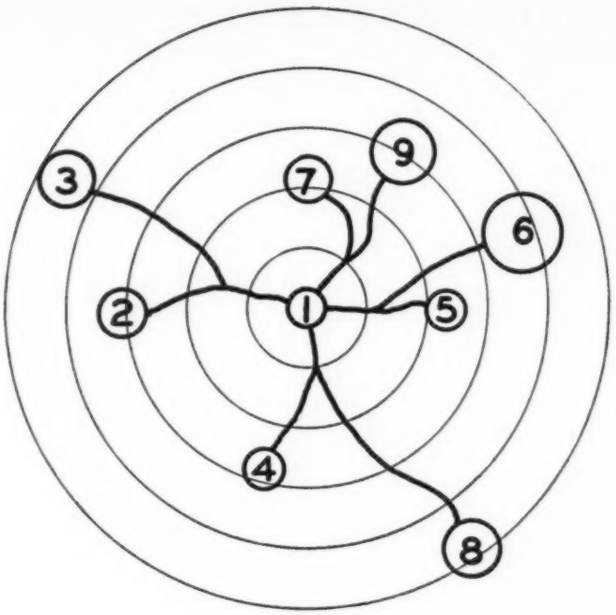

Fig. 1

The entire solution hinges about the derivation of the constant G which is assumed to remain constant at each location for which it is computed. If the future traffic is desired at more than one point in the area under consideration a value of G must be derived for each location. The accuracy of the constant G depends upon the length of time devoted to securing the traffic count. When the counts are made for a long period of time they will be of more value than short time counts as short counts have to be corrected for many variations, such as, hourly, daily, weekly and monthly. The value of G for any two areas is obtained by solving equation [5] for G:

$$G = \frac{TD^2}{R_1R_2} \quad \ldots . (6)$$

But as the actual traffic passing any one point on the highway is due to many areas the value of G^1 becomes:

$$G^1 = T^1c \quad \Sigma \frac{D^2}{Rc_1\ Rc_2} \quad \ldots . (7)$$

In which T^1 is the total traffic passing the traffic count station. The subscript c represents the value of the indicated quantities at the time the traffic count is made.

After solving for G the future traffic at any time is given by solving equation (5) for T:

$$Tf = G \quad \Sigma \frac{Rf_1\ Rf_2}{D^2} \quad \ldots . (8)$$

TABLE IV

AREA	R_{c_1}	R_{c_2}	D	D^2	$R_{c_1} R_{c_2}$	$\frac{D^2}{R_{c_1} R_{c_2}}$	R_{f_1}	R_{f_2}	$R_{f_1} R_{f_2}$	$\frac{R_{f_1} R_{f_2}}{D^2}$
2	800	1000	35	1225	800,000	.00153	960	1200	1,150,000	939
3	800	1500	50	2500	1,200,000	.00208	960	1800	1,730,000	692
4	800	850	30	900	680,000	.00133	960	1025	985,000	1095
5	800	750	25	625	600,000	.00104	960	900	864,000	1380
6	800	2500	45	2025	2,000,000	.00101	960	3100	2,975,000	1470
7	800	1200	28	784	960,000	.00081	960	1500	1,440,000	1838
8	800	1600	60	3600	1,280,000	.00282	960	2000	1,920,000	533
9	800	1900	34	1156	1,520,000	.00076	960	2300	2,210,000	1912
				$G^1 = T^1c \Sigma \frac{D^2}{R_{c_1} R_{c_2}}$		$\Sigma \frac{D^2}{R_{c_1} R_{c_2}} = .01138$		$T^1 = G^1 \Sigma \frac{R_{f_1} R_{f_2}}{D^2}$		$\Sigma \frac{R_{f_1} R_{f_2}}{D^2} = 9859$

the subscript denoting values of the indicated quantities at the time future traffic is desired. The value thus obtained is due to only two areas and as it is necessary to consider many areas the general equation for the solution of traffic problems may be derived:

$$Tf^1 = G^1 \quad \Sigma \frac{Rf_1\ Rf_2}{D^2} \quad \ldots . (9)$$

In using this formula the future traffic will be expressed in the same unit as the original traffic count, that is if the traffic count was the total yearly traffic the future traffic would also be for an entire year. For most cases it is advisable to base traffic counts on average daily traffic so that in using the formula it is only necessary to multiply by 365 in order to obtain the total yearly traffic.

General Procedure for Practical Study.—The general procedure in making a practical study will be briefly outlined so as to make clear any points that may have been overlooked in the derivation. The location of the areas and their highway connection to area 1 (the area in which future traffic is desired) is illustrated in Fig. 1. The concentric circles shown are at 10-mile intervals and the effective radius is assumed as 50 miles. A traffic count is made in area 1 and corrected for seasonal variations and in order to simplify the manual arithmetic involved it is advisable to express the traffic as average daily traffic. The work is further simplified by tabulating the various quantities and combinations that are used frequently (Table IV). The future traffic is then easily obtained for the condition outlined as it is only necessary to multiply G^1 by 9859 in order to obtain the traffic corresponding to Rf_1 and Rf_2.

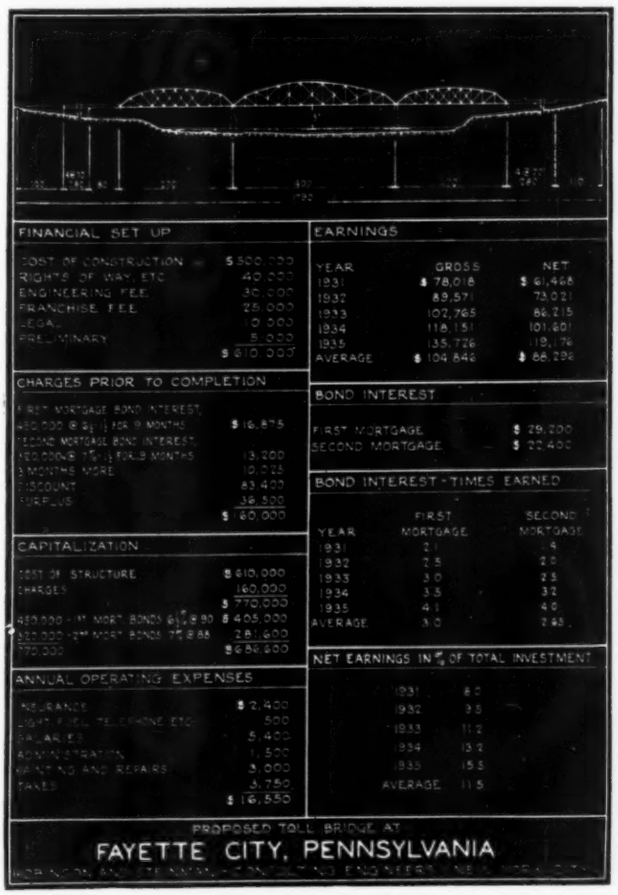

Fig. 2

Improvement of highway facilities always results in an increase in traffic, this increase in traffic volume is termed generation by the traffic engineer. The range of this generation is extremely large and depends upon local conditions and the character of the improvement. In cases where a ferry has been replaced by a bridge the percentage of increase has ranged from 50 to 800 per cent. This generation of traffic must be considered in any forecast of future traffic where proposed construction is contemplated.

Traffic Flow Pulse of Community.—What a blood circulation is to the living organism, the flow of traffic is to the town or city; it is the pulse of the community. The proper flow of traffic therefore must be considered as a fundamental need. When local traffic is able to move with ease and directness, conditions of business and living are benefited whereas any hindrance to traffic results in a lowering of efficiency. The capacity of the highway is a subject open to much thought as a comparison of capacity studies prepared by various authorities show considerable difference of opinion. Capacity is a function of vehicle length, spacing, speed, width of roadway, grade, curvature and many other minor factors. Johannesson expresses maximum density of traffic by the equation:

$$n = \frac{P}{0.025^p + 25} \quad \ldots (10)$$

Where n represents maximum density in number of vehicles per minute and P the rate of speed in feet per minute. The term 0.025^p is the distance traveled at the rate of speed P during a time of 1.5 seconds. The traffic capacity of a highway is reached when any further increase in traffic volume, all other factors remaining constant, results in a marked decrease in speed.

The economics of highway problems and design is perhaps the most important phase of highway engineering. Before any construction or proposed changes in the control of traffic can be started, a complete economic study based on the traffic survey must be made and only after thorough analysis and study of all factors can a decision warranting the project be made; for example, the construction of a private toll bridge, to be built and operated by a corporation for profit. A traffic survey is prepared which indicates volume and character of traffic as well as estimates of future traffic. Then by the establishment of toll rates it will be possible to determine earnings on the proposed bridge.

Financial Set-Up.—The financial set-up must include all charges which are construction charges, physical cost, right of way, engineering, franchise, legal, etc., as well as interest on the bonds during construction and the final capitalization will take into account any discount which may be required in order to sell the bonds. Earnings are determined from traffic, the operating and maintenance charges are deducted in order to obtain the net revenue which will determine the economic utility of the proposed bridge and its ability to meet interest and sinking fund charges. In order to receive favorable consideration by bond houses the bonds must show earnings of at least twice the required bond interest. A complete financial set-up is illustrated in Figure 2.

The foregoing is an abstract of a paper presented at the 1936 meeting of the American Toll Bridge Association.

New Book on Diesel Engines

ELEMENTS OF DIESEL ENGINEERING, by Orville Adams. First edition, 451 pages, 6x9-in., cloth-board covers. Published by The Norman W. Henley Publishing Co., 2 W. 45th St., New York, N. Y.

The author has written extensively on Diesel engines and had previously issued a large work on the subject. This book was produced primarily for the student and practical man who desires to understand the working principles and operation of the Diesel engine which in recent years has come into such prominence for industrial power applications. The author has doubtless read widely into the subject and has had a great deal of practical experience with such units.

The work is divided into 20 chapters, each well illustrated and containing questions and their answers at the end of each for review. The subject is begun with an outline of the historical development of the Diesel and continued in Chapter I with the elements of operation; peculiarities and problems of the Diesel cycle; definitions of standard terms; and efficiency factors. The next three chapters are occupied with Diesel fuel-injection systems and combustion chambers describing and grouping the various types of systems and their principles. A large place is given to those most important parts—the injection pump and its counterpart, the injection nozzle.

A section is devoted to those low-compression engines employing injection of fuel oil but relying on a spark to ignite the charge instead of the heat of compression. In touching the subject of Diesel fuels, their properties, chemical structure and test methods are given with observations. Three chapters may be thought of as dealing with such mechanical parts of the Diesel as: pistons, cylinders and liners; piston rings; and bearings—discussing factors involved in design and maintenance. There follows chapters devoted to lubricating oils, their behavior in an engine and purification; air intake and exhaust systems in their elementary treatment with typical installations; and the selection and installation of Diesel engines and auxiliaries.

The author then relates many factors in the development of the high-speed Diesel and its component parts, devoting one section to European development; another to that in America along with many economic considerations; and another to development in certain parts of such engines. In the closing five chapters (about 75 pages) the subject of operation and maintenance is presented involving: service routine and engine operation; engine adjustment and factors of successful operation; detailed procedure in dealing with the cylinder head and valve mechanism, cylinder and piston, piston rings, bearings and their adjustment, etc., and finally, a discussion of lubrication practice, governor operation, starting systems and cooling systems from the operator's point of view.

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Four States Now Have Constitutional Anti-Diversion Provisions.—Missouri, Minnesota, Kansas, and Colorado, now have provisions in their constitutions to prevent the diversion from highway purposes of the receipts of their gas tax and motor vehicle fees. In Nebraska, initiative petitions are being circulated to give voters an opportunity to vote it at the general election on November 3rd on a constitutional amendment prohibiting use of highway funds for purposes other than highway financing. At present only two-thirds of the state's gasoline tax revenue is used for roads.

CEMENT BOUND MACADAM CONSTRUCTION AT BENTON HARBOR, MICH.

By C. R. WIGHTMAN
Director Department of Public Works, Benton Harbor, Mich.

IN the Spring of 1935, estimates were prepared for about 4 miles of cement bound macadam under the FERA set-up. The cost of materials, the wages of key men, such as foremen, mixer man, and finishers, and the necessary truck hire, were charged to the frontage of the property pro-rata. The common or relief labor costs were passed to the benefit of the property owners subject to assessment for the work. Later on, using the WPA set-up, new projects had to be formulated. In these, 15 per cent of the material costs and 50 per cent of the truck hire were included in the Federal contribution and this saving was allocated to the City Street Fund to pay for street and alley intersections.

The special assessments were spread over a period of 10 years, deferred payments bearing 5 per cent interest. Bonds anticipating the special assessment payments were issued and sold at a premium and these funds made available for the payment of materials and wages of key men such as it was necessary to use on the work.

Power Shovel Reduces Excavation Cost.—We started out using FERA labor to do the excavating, but as the city was then paying the cost of trucks, we found that the excavating costs were running over our estimates, even with free labor, due to the low factor of efficiency of FERA labor. It was costing us from 15 to 30 ct. per cubic yard to do this excavating. To reduce this cost a ⅜ cu. yd. gas powered shovel was purchased, with the result that we are now handling this excavating at a cost of from 6 to 10 ct. per cubic yard.

The organization on our work is substantially as follows: For heavy grading, a ⅜ cu. yd. gas powered shovel and from 6 to 10 trucks, depending upon the length of the disposal haul. The operator of the shovel is a regular employe of the Department of Public Works.

On this division of the work we also have a city foreman who looks after the grades and 2 or 3 WPA employes for handling mats and incidental work around the shovel.

Next come the form setters, consisting entirely of WPA employes, in number about 6 or 8.

Fine Grading and Placing Stone.—Six inch forms are set upon the center line to the crown grade of the street and a 6-in. form on one side of the street on the back line of the curb. Then come the fine graders, headed by a regular department foreman, with 10 to 14 WPA employes and the necessary trucks to prepare the sub-grade to receive the aggregate.

Next we have the stone gang, headed by the raker, who is also a regular department employe and aided by 3 rakers from the WPA ranks and 2 or more laborers to do the dumping. As a truck is dumped, it moves forward, spreading the stone as nearly as possible to the proper depth. The rakers then rake the stone to a template moved along the forms by 2 WPA employes. Following this template comes the tamper, consisting of a 6 in. I-beam, approximately 12 ft. long and fitted with plow handles. This tamper is handled by 2 WPA men and weighs approximately 180 lbs. and is worked longitudinally.

Following the longitudinal tamper, a template consisting of two 2 x 6 planks, shod with 2 angle irons, manned by 2 WPA men, is worked transversely. Two WPA men follow closely with forks and rake to correct discrepancies in the cross section. After this tamping, the stone is ready for the grout.

Grouting.—The grout crew is under the direction of a city foreman and consists of a mixer operator, also a department employe, 4 WPA men as broomers, who spread the grout as it is poured on the work, and 2 WPA men opening the cement and emptying it on the batch trucks; 2 WPA men with a template tamper similar to the one used on the stone, tamping the grout as it is broomed into place.

These tampers are followed by the finisher, a regular Department employe, who, using a wood float 6 in. x 48 in., fitted with a long handle, floats off the surplus water and corrects any high or low spots, after which he, aided by WPA men, completes the finishing process by dragging the surface with a sheet of burlap drawn along the top with a transverse saw motion.

Curb Construction.—The building of the integral curb follows closely as possible upon the finishers. A 6 in. form is placed on top of the slab form and a wooden face form provided with iron clamps is placed in position, after which the form is filled with a 1-2-3 concrete mix made in a 1-sack mixer. After the concrete has been tamped, the wood form is removed and the top of the curb is then formed with a home made tool having the form of a cross-section of the curb.

This tool has a removable sleeve which fits over its edge and after the curb has been formed and the wood form removed, the sleeve is removed from the tool and the mortar facing tooled into place, the finishers then touching up any defective spots with wood flats, the job is completed.

The curb crew consists of 1 department finisher, 2 finishers from the WPA, 2 WPA men mixing the curb concrete, 2 WPA men wheeling from the mixer to the forms and 2 or more laborers in addition to the men already mentioned, handling forms and such work as may be incidental to this curb building.

From 10 to 20 common laborers are employed in taking up and cleaning forms, dressing off tree lawns

and such other jobs as from time to time arise. After the final finish, if the weather is hot, we cover the slab with about 2 inches of planer shavings and sawdust, which are sprinkled and then we allow from 4 to 6 days for curing. In the Fall of the year, leaves have been used in lieu of shavings and sawdust, another Scotch idea, and when there was a possibility of frost, we covered the pavement with marsh hay.

Details of Construction.—The subgrade should be prepared with the same care that you would bestow on it if mixed concrete were to be used. In placing the aggregate, we lay only ½ the width of the slab from one end of the street to the other, and in placing stone, we start midway between two cross streets to obviate the long back up for trucks.

The center form used has a triangular strip 2 in. x 2 in. bolted to the face side to form a V-shaped key groove. The second half of the slab is thus keyed against heaving or settlement.

Great care should be taken to keep out fine stone, as it will interfere with the free flow of grout and result in poor penetration. The effect of fine aggregate is very clearly shown in one of these cores. We rescreen all of our aggregate in loading trucks and the fines which are screened out are used for our curb concrete.

In building the Elmhurst test road, the aggregates were rolled before and after grouting. On our first work we attempted to use the roller but found that the stone shoved ahead of the roller and a wavy surface resulted. Consequently, we abandoned that practice and relied entirely on tamping, with much more satisfactory results.

For grouting, we use a 14 E mixer with a 21 E drum, using 5 bags of cement per batch. This mixer we equipped with a special discharge to prevent slop over. We also have a drop curtain on the charging side for the same reason. This mixer was formerly equipped with a boom and bucket and we tried to use it in that form, but found that segregation occurred in our grout, and so quit using the bucket and adopted a straight gravity chute. We equipped this chute on the end with a perforated box (part of an oil drum) with ¾ in. holes, 2½ in. centers on the bottom and 2 rows of holes around the side. These we found undesirable, consequently we plugged them with wood plugs.

A piece of ⅛ in. steel, approximately 24 in. square, with a hinged handle, somewhat like a snow shovel, is used under the grout box, to break the force of the discharge and thus obviate the displacement of the aggregate. We also use a mat of ¾ in. mesh hardware cloth, about 8 x 12 ft., wired to an iron frame of ½ in. round iron. This mat makes it much easier to properly broom the grout into place without displacing the stone.

We also sprinkle the aggregate lightly before grouting. The grout top finish should be kept as thin as possible without exposure of the aggregate.

Expansion joints consisting of two thicknesses of ½ in. Celotex, 6 in. deep, previously dipped in cut back asphalt and placed every 50 ft., by digging out the stone after it has been placed and then replacing by hand.

The sand used for grouting is No. 14 or plastering sand. On our work 2.2 cu. ft. per sack of cement are used.

One of the most essential considerations is the fluidity of the grout. The proper consistency of the grout is determined by the use of a standard flow cone. This cone is 7 in. in diameter at the top, the vertical walls are 3 in., and the altitude of the cone is 7½ inches. The orifice is a brass pipe 1½ in. long and ½ in. internal diameter. This cone is filled level full and after 5 seconds the orifice is opened and the flow is carefully timed with a stop watch. With aggregate ranging from 1½ in. to 2½ in., we find that grout of ideal fluidity will empty the cone in from 20 to 23 seconds.

We find that a water ratio of from 6 to 6½ gal. per sack of cement will produce this result, depending upon the moisture content of the sand. These cone tests are taken frequently, but an experienced mixer operator can tell very closely if his mixture is right.

For a 5½ in. slab such as we have been laying, the materials required per square yard of paving, including the curb, are:

Cement	.2016 bbl.
Gravel	.2001 tons
Sand	.0569 cu. yds.

This is approximately 5 sq. yd. of pavement grouted per barrel of cement. The cost of curb on our work is just a little less than 6 cts. per lineal foot.

On 16 projects built last year, the front foot cost to property owners ranged from $1.47 to $2.45, depending upon amount of excavation and storm sewers required.

The average of the 16 projects was $1.80 per front foot.

Abstract of a paper presented at the 1936 Purdue Road School.

▼

Rural Mail Services Improved; Cost Less

Rural mail delivery routes are getting longer and the number of rural carriers is getting smaller. During the last 25 years, total mileage of routes has increased more than 34 per cent, while the number of carriers has decreased from 41,559 to 34,763, according to an analysis of Post Office Department figures just made by the National Highway Users' Conference.

This analysis, showing effect of increased use of automotive and highway facilities, reveals that the average length of rural delivery routes last year was 62 per cent greater than it was in 1904.

Routes once covered by "horse and buggy delivery" have been consolidated as carriers left the service. Through consolidations, 2,260 routes were discontinued during the last fiscal year, with an actual saving of $1,350,306 being effected in that year as a result.

"Although the consolidation of routes does not as a rule result in any material reduction in mileage," the Post Office Department reports, "it reduces the rate of cost and places the service on a basis in keeping with the advantages afforded by improved roads and transportation facilities."

▼

Research—Dissatisfaction—Progress

One of the fundamental purposes of research is to foster a healthy dissatisfaction.

Entirely apart from the scientific relationship of research, if there is one function more important than another, it is this—to make people recognize that they are living in a state of change. The world hates change, yet it is the only thing that has ever brought progress.

—Charles F. Kettering.

POWER when you need it—SPEED when you want it in the INTERNATIONAL 2-Speed Axle

An International with 2-speed rear axle. These trucks bring new performance and economy to jobs like yours.

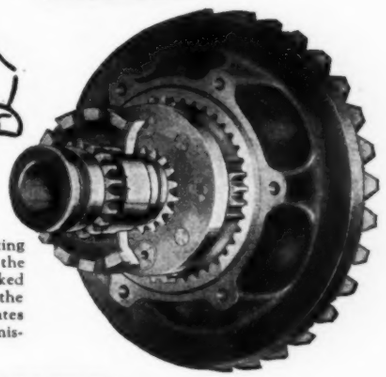
● The 2-speed rear axle trucks available in the International line now make it possible for truck users to obtain both high-speed and low-speed performance in one unit. A simple movement of the shifting lever changes the axle ratios instantly and silently without stopping the truck. The low-gear ratio provides *power* for hauling heavy loads through tough going and up steep hills, while the high-gear ratio allows *high speeds* on level roads or with light loads.

The extreme flexibility of these dual-range, full-floating rear axles enables the International 2-speed axle trucks to do more work at lower cost. When shifted to the low gear, the speed of the engine remains constant, but the speed of the axle and wheels is reduced, thereby providing unusual pulling power. In high gear, of course, the wheel speed is increased.

When you see these 2-speed rear-axle Internationals in action in a tough spot, you will get a good idea of what they can do for you. Ask the nearest Company-owned branch, or International dealer, for a demonstration. There is a full range of other trucks in the International line, from the Half-Ton unit to the powerful Six-Wheelers.

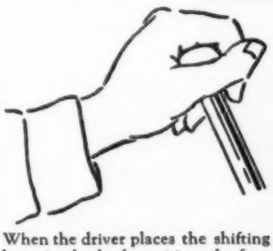
INTERNATIONAL HARVESTER COMPANY (INCORPORATED)
606 So. Michigan Ave. Chicago, Illinois

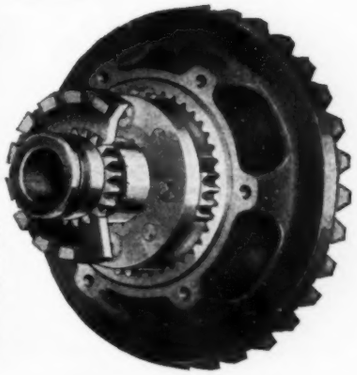
FORWARD for SPEED



When the driver places the shifting lever in the forward position, the four planetary gears are in the locked position and turn as part of the differential. The truck then operates as a high-speed unit in all transmission gears.

BACK for POWER





When the driver places the shifting lever in the back position, the four planetary gears are in the unlocked position, which allows them to rotate around the locking gear, thereby making a silent reduction of axle speed. The truck then operates in all transmission gears as a powerful low-speed unit.

INTERNATIONAL TRUCKS

PERPETUAL MOTION IN PLAN PRODUCTION

By VICTOR J. BROWN
Publishing Director Roads and Streets

PREPARING plans for Mississippi's $42,500,000 highway program has developed into a high speed factory type operation. This was necessitated in order that the PWA regulations could be met, which requires all funds to be under contract by July 1, 1937. The projects upon which the money is to be spent must receive the approval of the U. S. Bureau of Public Roads acting for the administrator of the PWA.

All survey crews available this spring were thrown into action on original surveying; practically none had been done prior to December, 1935. As rapidly as possible these surveys are turned into blue prints. This is the factory production feature.

The drafting force is divided up into three shifts. Each shift works eight hours as follows:

1. 7:00 a. m. to 3:45 p. m. (45 min. for lunch).
2. 4:00 p. m. to 11:00 p.m. (short shift makes up time on Saturday).
3. 11:00 p. m. to 7:00 a. m.

Each crew works on a certain project, the next one on a different project and so on. In this way no overlapping of effort or conflicts in design-features creep in. Below is a discussion on how the surveys and plans are routed through the commission office. The temper and spirit around the commission office is good for one to see. It brings back memories of boom-time action. All effort seems to be directed toward one goal—completion of the plans so that full advantage may be taken of federal funds already set aside to pull Mississippi out of the dust and mud.

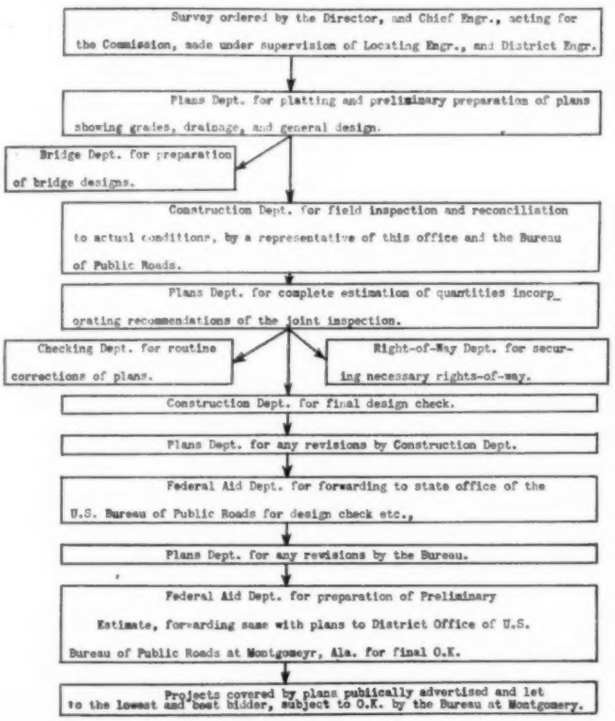
Plan Preparation

All field notes with necessary sketches, right-of-way maps, continuous profile plans, coil profiles, drainage area plats, etc., are received at Jackson by the chief location engineer from the district engineers of which there are four. The data are checked and a memorandum is furnished to all department heads stating that the information is available. As a job is needed in the drafting room, all necessary notes, sketches, etc., are secured from the chief location engineer. Work on the job starts after the fashion of the well known Ford assembling line, equaling if not surpassing it in efficiency. When the plans are completed for the preliminary field inspection all notes, sketches, etc., are returned to the chief location engineer to be filed for future use. In the drafting room these plans, notes and other information are kept together by squads. Each squad works on a particular project except for laying the grade line, which is done by one man. At the close of work of that shift, all paper are bound up in a canvas roll similar to a miniature bedding roll used by army officers. This roll covering was devised by Mr. J. F. Fonville, Engineer of Plans. It keeps the work of one squad all together.

After the plans are returned from the field inspection they are corrected, if needed, and completed in the drafting room. They are checked there to see that they conform to the requirements of the U. S. Bureau of Public Roads, and to see that the job can be constructed satisfactorily. The next step is to make blue prints for the sets necessary to be sent to the State Office of the U. S. Bureau of Public Roads (the District office is at Montgomery, Ala.), the Proposal Department, and the Right-of-Way Department.

The State Office of the U. S. Bureau of Public Roads (Mr. Fred A. Davis, Engineer) then reviews the plans. The corrections or suggestions are made and an estimate is prepared by the Federal Aid Department. Proposals are prepared by the Proposal Department and then the complete assembly, consisting of plans, estimates, and proposals, is again sent to the State office of the Bureau of Public Roads for their review before being forwarded to the District Office of the Bureau for final review. If approved, the District office of the Bureau authorizes the advertisement of the job.

Receipt of authorization to advertise permits the Director of the Highway Commission to enter advertisements in local and state papers as required by law. Contracts are then let in the customary manner. In a reasonable time after award of contract, work orders are issued and construction begins. The system followed in Mississippi is to stipulate a contract time in "working days." Resident or project engineers will determine what day or parts of a day is a "working day."


Survey ordered by the Director, and Chief Engr., acting for the Commission, made under supervision of Locating Engr., and District Engr.
Plans Dept. for platting and preliminary preparation of plans showing grades, drainage, and general design.
Bridge Dept. for preparation of bridge designs.
Construction Dept. for field inspection and reconciliation to actual conditions, by a representative of this office and the Bureau of Public Roads.
Plans Dept. for complete estimation of quantities incorporating recommendations of the joint inspection.
Checking Dept. for routine corrections of plans.
Right-of-Way Dept. for securing necessary rights-of-way.
Construction Dept. for final design check.
Plans Dept. for any revisions by Construction Dept.
Federal Aid Dept. for forwarding to state office of the U.S. Bureau of Public Roads for design check etc.,
Plans Dept. for any revisions by the Bureau.
Federal Aid Dept. for preparation of Preliminary Estimate, forwarding same with plans to District Office of U.S. Bureau of Public Roads at Montgomeyr, Ala. for final O.K.
Projects covered by plans publically advertised and let to the lowest and best bidder, subject to O.K. by the Bureau at Montgomery.

Successive Steps in Plan Preparation for Mississippi's $42,500,000 Highway Program

YOU, TOO, CAN SAVE WITH THIS TRIPLE PROTECTED TRUCK TIRE

"Toughest job there is for tires!" That's what loggers will tell you about their operation. Trucks have to fight their way through cut-over-timberland, plow through sand and swamps in the south, find a foothold on icy hills in the north. Many a logging truck never sees a highway! All carry heavy, swaying loads that murder ordinary truck tires.

That's why dollar-minded loggers everywhere choose Goodrich Silvertowns. These tires are Triple Protected. They're made especially for the world's toughest hauling jobs. They ask no favors. Need no "second chances" to make good.

It's because Goodrich Truck Tires have a new invention built into the sidewall—a 3-way check against blowouts and breaks. This protection actually checks 80% of premature failures! It makes tires wear longer. It cuts down on delays—saves on repair bills. No wonder loggers choose Goodrich.

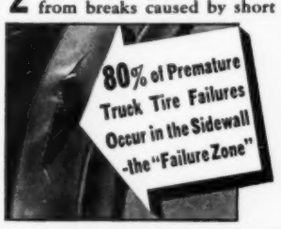
Whether it's a load of logs—or pork—or paper—whether you travel country roads or broad highways, the same Triple Protection that makes Goodrich Tires stand up in the lumber industry will make them stand up longer for you.

HOW TRIPLE PROTECTION WORKS

1 PLYFLEX—distributes stresses throughout the tire—prevents ply separation—checks local weakness.

2 PLY-LOCK—protects the tire from breaks caused by short plies tearing loose above the bead.

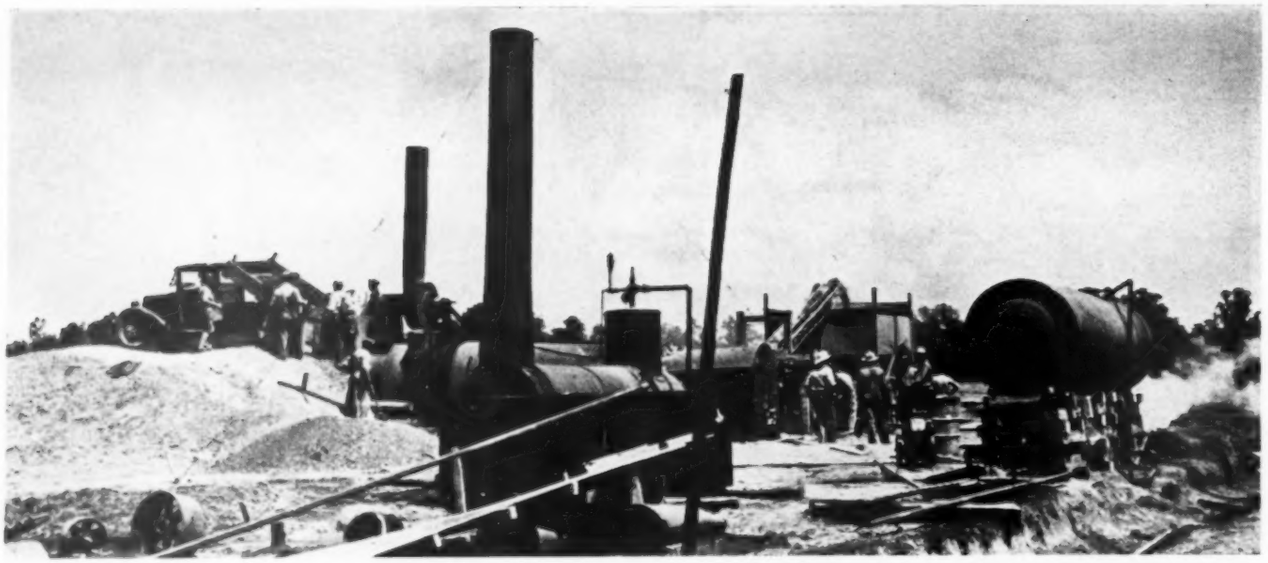
3 100% FULL-FLOATING CORD—eliminates cross cords from *all* plies—reduces heat in the tire 12%.



♦ © 1936, The B. F. Goodrich Co., Akron, Ohio.

Goodrich Triple Protected Silvertowns

SPECIFY THESE NEW SILVERTOWN TIRES FOR TRUCKS AND BUSES



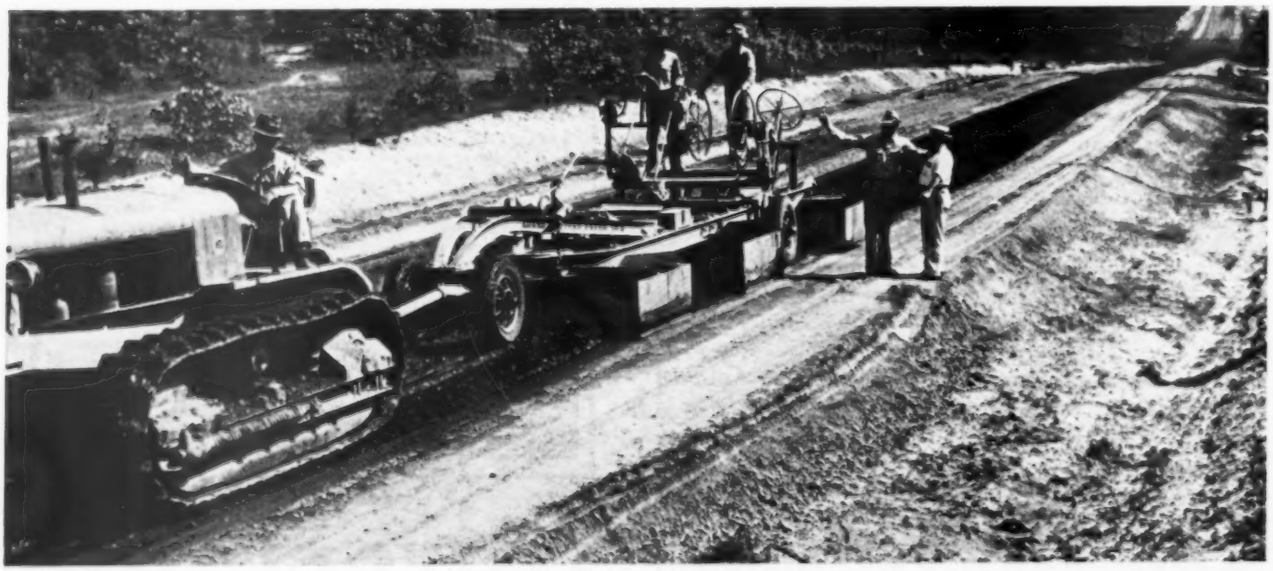
Gravel Drying Plant. Trucks Hauling Gravel to the Drier Were Loaded at the Pit Adjacent to the Plant by P.W.A. Hand Labor

A BLACK TOP, PWA JOB ON U. S. 167 IN SOUTHERN ARKANSAS

A BITUMINOUS mixed-in-place job now in progress in Southern Arkansas presents an interesting illustration of the adaptation of local materials to the job. The contract extends 11 miles north of Eldorado on U. S. Highway No. 167. The contractor, A. G. Kennedy of Little Rock, Ark., is using an Adams retread paver No. 3 to do all of the mixing and finishing.

Pit-Run Aggregate Used.—The aggregate used is pit-run gravel obtained about 4 miles from one end of the job. The gravel contains from 5 per cent to 14 per cent clay and inasmuch as the material is moist when taken out of the bank, specifications call for drying to reduce the moisture content to not more than 2 per cent. As this is a PWA project hand-labor is being used in the pit to load the gravel into trucks to be hauled to the drying plant. From the drier the material is carried on a belt conveyor into a storage bin, from where it is loaded into trucks for hauling to the job. The aggregate is spread on the road to a depth of 2¾ in. through a common stone-spreader box.

The Surface.—The new surface is being laid over a 6 in. gravel base which is planed to a true surface with the paver. A Hough sweeper is then used to sweep the surface clean of all dust and loose particles. Following the sweeping the surface is shot with a prime



Retread Paver in Operation on U. S. 167, North of Eldorado, Arkansas

HIGHWAY OFFICIALS! THREE WAYS TO BETTER ROADS AND STREETS

BETTER roads are now within the means of every community, every county and every state. Through the use of calcium chloride any dirt or gravel road can be made smooth, dustless and firm. There are three phases of improvement, each requiring a relatively small outlay of money, yet each producing results worth many times its cost.

1 SURFACE DUST TREATMENT, the first step in road improvement: consists of spreading calcium chloride on the road to prevent dust and loss of road materials. Two or three light applications of calcium chloride during the season are usually sufficient to maintain the road in perfectly dustless condition. Even the smallest road budget can afford this method of eliminating the waste, danger, discomfort and contamination caused by dust.

Method 1

Calcium Chloride being applied uniformly on road for dust-proofing.

Method 2

Distributing clay for bonding loosened aggregate or float material. (Has proven highly successful in Michigan maintenance practice)

2 GRAVEL-CLAY TOP-DRESSING, ordinarily a maintenance function in the case of gravel surfaces: consists of adding just sufficient clay to the loose surface material to bind it. The effect is a "skin treatment" which, through the addition of calcium chloride produces a remarkably smooth closed surface, practically eliminating blading except after rains. The operation is reversed by adding aggregate (chiefly sand) when the surface has excessive cohesive material (clay).

3 STABILIZATION, the comparatively new science of using familiar soil materials to build pavement-like road surfaces: Through years of research and tests, soils engineers have established definite formulas whereby soils having characteristic properties—such as cohesion and friction—can be combined in correct proportions to form a stable soil mass. Calcium chloride is added to provide the moisture bond. The resulting surface is smooth, dustless and—amazing as it seems—so hard that it is difficult to dig into even with a pick-axe. A calcium-chloride-stabilized road is truly an all-weather road and, with extremely economical maintenance, can be kept in perfect condition the year-round.

Method 3

A smooth, dustless all-weather road in DeKalb County, Illinois, accomplished by calcium-chloride-stabilization as described.

WRITE FOR LATEST BULLETINS

No. 18—Maintenance of Stabilized Roads, No. 20—Specifications for Stabilized Roads, No. 21—Computing Quantities of Materials for Stabilized Roads, No. 22—Outline of Stabilization, No. 23—Importance of Crown, No. 24—Plant Mixing Calcium-Chloride Stabilized Soils.

The various phases of soil stabilization are thoroughly covered in these bulletins, based on latest findings of research engineers. Additional technical literature is available on all phases of low-cost road improvement with calcium chloride. Write for this information today.

CALCIUM CHLORIDE ASSOCIATION

SOLVAY SALES CORPORATION
40 Rector St., New York City
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CALCIUM CHLORIDE
FOR ROAD IMPROVEMENT

Road Before Work Was Started. Shows Dust as a Result of Traffic.

Sweeping Loose Material from Gravel Base Before Applying Prime Coat.

coat of 1/10 of a gallon of MC-1 asphalt. This prime coat is allowed to dry and set for three days before the aggregate is placed on the road.

The bituminous binder is asphalt cut back with kerosene—material from a local refinery. It is applied at the rate of 1.3 gal. per square yard through a Littleford Model C distributor. The asphalt is put on in three applications with the paver making a mixing trip immediately following the distributor after each application. Following the final application, the paver, of course, goes ahead with the mixing operation, leaving the material in windrows in order to accommodate traffic.

After the mixing is completed, the material is allowed to lay on the road in windrows from 24 to 36 hours for "curing" or to allow some of the Kerosene cut-back material to evaporate. During this curing period the paver is run through the windrows at intervals to quicken the process.

When the mixed material is properly cured, it is laid out and finished with the paver to an 18 ft. width. As a guide to the finishing operator steering the rear end of the paver, a string line is laid to designate the edge and the paver lays the material right down to the line. Following the finishing trip, of course, the surface is rolled.

This job is being worked in ½ to ¾ mile sections, the length of a day's run being limited to the amount of gravel that can be run through the gravel drying plant.

Another View of Retread Paver

Completed Surface. Photograph Taken from Approximately Same Point Shown in Illustration on Preceding Page

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*Illustrated above is Mr. Bazley's THIRD 10-B!

BUCYRUS ERIE

EXCAVATING, DRILLING, AND MATERIAL HANDLING EQUIPMENT...SOUTH MILWAUKEE, WISCONSIN, U.S.A.

MAINTENANCE OF BITUMINOUS MATS IN KANSAS

By L. L. MARSH

Assistant Maintenance Engineer, State Highway Department, Topeka, Kan.

AN act of the Legislature in 1929 authorized the construction and maintenance of highways under the supervision of the State Highway commission. By 1930, a small mileage of sand-gravel and chat surfaced roads had been extended to more than 3,000 miles. Immediately an increase in traffic volume was noticeable and the disadvantages of these types became apparent. The roads were dusty, and in time became corrugated and required more surfacing material. This had to be stored in windrows along the shoulders and constituted a traffic hazard.

Types of Bituminous Surfacing.—In 1930 the state highway department commenced using bituminous materials in an effort to develop a surface that would eliminate the above mentioned difficulties and conserve some of the original investment in construction. The first attempt was a project approximately seven miles long on which 1,200 cu. yd. per mile of fairly well graded sand-gravel aggregate and a light asphaltic road oil were used. This type of surface is known as "heavy mat." The large mileage of existing sand-gravel surfaces and limited funds required the use of bituminous surface that would cost less than $2,000 per mile. A "light mat" was developed. This requires approximately 500 cu. yd. of surfacing per mile and is laid on a penetrated base.

In 1933, Kansas began constructing an "oil penetration" bituminous surface which costs on the average less than $1,000 per mile. All loose material, such as sand, chat, or limestone gravel is windrowed to the shoulder. The quantity of this material varies from 125 to 200 cu. yd. per mile. After the base has been cleaned it is given a penetration application of light medium curing cutback of 0.5 gal. per square yard. As soon as the first application has penetrated, 0.3 gal. per sq. yd. of MC-2 or MC-3 oil is applied and immediately covered with the same material.

At the present time the Kansas State Highway Department maintains the following mileages of these types of surfacing:

	Miles
Heavy mat	105.0
Light mat	1672.4
Oil penetration	1019.9
Total	2797.3

Maintenance Crews.—Maintenance problems have multiplied with increased oil processed mileage. Kansas is divided into six divisions and each division is subdivided into four or five districts. Each division has a trained oil crew, an 800 gal. distributor, necessary blade equipment, and from one to five 1½-ton trucks. This crew covers an entire division. Its duty is to attend to major repairs, such as sealing long sections, scarifying and reconditioning mats, shoulder oiling and if necessary, base repair. This crew is also equipped to build any type of bituminous surface.

With the exception of equipment, the district oil crew is essentially the same as the division oil crew. The district crew has a 2-wheeled trailer distributor of 300-gal. capacity, a 1½-ton truck and small tools. Patching material is available at the section man's shed. The district oil crew is responsible for minor repair jobs in the district. These include spot sealing, patching, and repairing short sections. If only routine maintenance is necessary the district crew is available for other maintenance duties.

The section crew consists of one man and a helper and maintains approximately 30 miles of oil processed highway. The section crew has a 1½ ton truck, a light blade, roller, mower, snow fence, snow removal equipment and small tools. Patching material and small storage space for oil are provided as mentioned above. The section man patches small faults, rolls shoulders, cleans the right of way, repairs shoulders and ditches and resets guide posts, guard rail posts, and road signs. Standard section-man's garages are being designed at the present time. These are to be built in panels and will be semipermanent but capable of removal. In general, each garage will be located near the middle of a section and will include about an acre of ground which will be suitably fenced so that it can be used for storage purposes.

Surface Maintenance.—Surface maintenance is a large part of the work necessary on a bituminous surfaced highway. The oil penetration or "blotter" pavements may require supplemental surface sealing or resurfacing each year. In Kansas the following method is used. Approximately 115 cu. yd. of surfacing material per mile of highway are windrowed along the shoulder of the section to be treated. This material may be sand-gravel, chat or crushed stone but in no case is more than 5 per cent retained on a ¼-in. sieve and not more than 5 per cent of the sand-gravel or crushed stone passes the 8-mesh sieve while 15 per cent of the chat may pass the 30-mesh sieve.

The sandspreader has been used but studies indicate an increase in cost from $40 to $80 per mile and it is not believed its advantages over the blade justify this additional cost; however on narrow roads lack of space for the windrow may require the use of a sandspreader. After the windrow of cover material has dried, approximately 0.25 gal. per square yard of MC-2 or MC-3 oil is applied to the surface and immediately covered. Medium curing cutbacks are used in the fall.

Traffic Census.—The maintenance department is responsible for the traffic census. At each counting station, the traffic is classified and its volume noted on a standard form. At the end of each day's count these reports are delivered to the district supervisor who submits copies to the division office and to the headquarters office. Headquarters office compiles all information from the field and prepares the yearly traffic census map. Charts showing traffic flow for each hour

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FLOW-LINE

—means speedy and full chute discharge for Koehring 28-S, 56-S and 84-S Concrete Mixers used for central mixing plants and large volume concrete construction jobs. The Flow-Line discharge permits a natural flow of concrete, reduces abrasive wear, causes a minimum of segregation—decreases discharge time.

KOEHRING HEAVY DUTY

KOEHRING COMPANY

Pavers · Mixers · Shovels · Cranes · Draglines · Dumptors · Mud-Jacks

3026 WEST CONCORDIA AVENUE, MILWAUKEE, WISCONSIN

Yes—We would like you to mention ROADS AND STREETS

TABLE I.—HEAVY MAT FROM PERIOD JULY 1, 1933, TO JUNE 30, 1934

Section Number	Length Miles	24 Hour Traffic	Original Cost Per Mile	Routine Maintenance Per Mile Per Year	Surface Maintenance Per Mile Per Year	Resurfacing Plus Surface Maintenance Per Mile Per Year	Resurfacing Plus Routine Maintenance Per Mile Per Year
1	16.0	500	$3,679	$149.88	$72.56	$336.56	$413.88
2	8.4	567	6,489	160.69	57.36	57.36	160.69
3	16.0	631	4,342	167.62	85.59	85.59	167.62
4	7.0	732	4.187	365.95	253.51	433.51	545.95
	47.4	500 to 732	4,674*	211.04*	117.26*	228.26*	322.04*

of the day in relation to the average total traffic for the day, and a comparison of foreign traffic with local and commercial traffic with total traffic are included with the traffic census map.

Cost Distribution.—Cost distribution of maintenance involves a number of considerations. Every portion of the highway is located by route sections, the limits of which are established by county lines and intersecting highways. When a section man is assigned to one or more route sections, he is given a complete code outline that covers all types of work. At the end of the day, his time is charged to the proper work. All rentals and materials are charged in the same way. At the end of the month, time and rental distribution sheets and material transfers are submitted to headquarters and charged against the proper route sections. At the end of each fiscal year all costs for each type of road surface for each route section is made available by the auditor and it is then a simple matter to correlate traffic and costs.

Cost analysis.—Typical data for the three types of oil processed highways are shown in Tables I, II, and III. All sections are complete maintenance sections and in each section there is only one type of surface. Sections are taken indiscriminately from all parts of the state and no attention has been paid to type of aggregates, oil, or physical characteristic of the grade on which the surface is laid. Routine maintenance includes surface maintenance, shoulder treatment, drainage, roadside improvement, snow removal, guide line painting, detours, and all work on highway route markers, but does not include resurfacing. Surface maintenance work includes all work chargeable to surface, such as spot sealing, remixing small areas of corrugated, bleeding or dry cracked mat, and patching pot holes and ravelled edges. All materials are included in this item. The other items require no explanation.

Relation Between Traffic Volume and Maintenance Costs.—A study of Table II indicates a close relation between traffic volume and maintenance costs on oil penetration highways. After traffic reaches approximately 600 vehicles per day there is a well defined increase in cost that is reflected in both routine maintenance and surface maintenance items. Resurfacing costs increase from an average of $379.87 per mile per year on sections carrying up to 590 vehicles per day to an average of $486.67 per mile per year on sections which carry from 590 to 1013 vehicles.

Reference to Table III shows that on "light mats" maintenance and surface maintenance tend to decrease from an average of $462.17 to $381.61 on sections carrying 204 to 597 vehicles per day to an average of $407.50 and $323.23 on sections carrying 1023 to 2028 vehicles per day. Resurfacing and routine maintenance increases as the volume of traffic increases. It is seen that surface maintenance is essential and that expenditures on the surface bear a fairly direct rate to the volume of traffic.

Essentially the same conclusions are true of the heavy mats; however only limited studies are available and in these traffic range varies from 500 to 732 vehicles per day. With the same traffic volume the total maintenance costs of the heavy mats are approximately one half the costs of the light mats or oil penetration mats.

Authorities disagree on how resurfacing should be classified. Some state that when applied to bituminous surfaces all resurfacing changes are additions and improvements. If this is true all routine maintenance work chargeable to surface should be carried on an addition and betterment charge. It is noted that on oil penetration roads "surface maintenance" and "resurfacing" costs increase with the traffic volume. On the light mat highways "surface maintenance" decreases somewhat with traffic volume but "resurfacing costs" increase appreciably. This shows that increase in traffic adds to surface costs regardless of how the work is done. It seems therefore that unless it is considered that the type of surface is changed due to the sudden addition of materials, resurfacing should not be considered a betterment. For instance an oil penetration mat might be changed to a light type mat but in this case the maintenance cost of either type is approximately the same for the equal volumes of traffic.

Other Factors.—Other items may affect maintenance

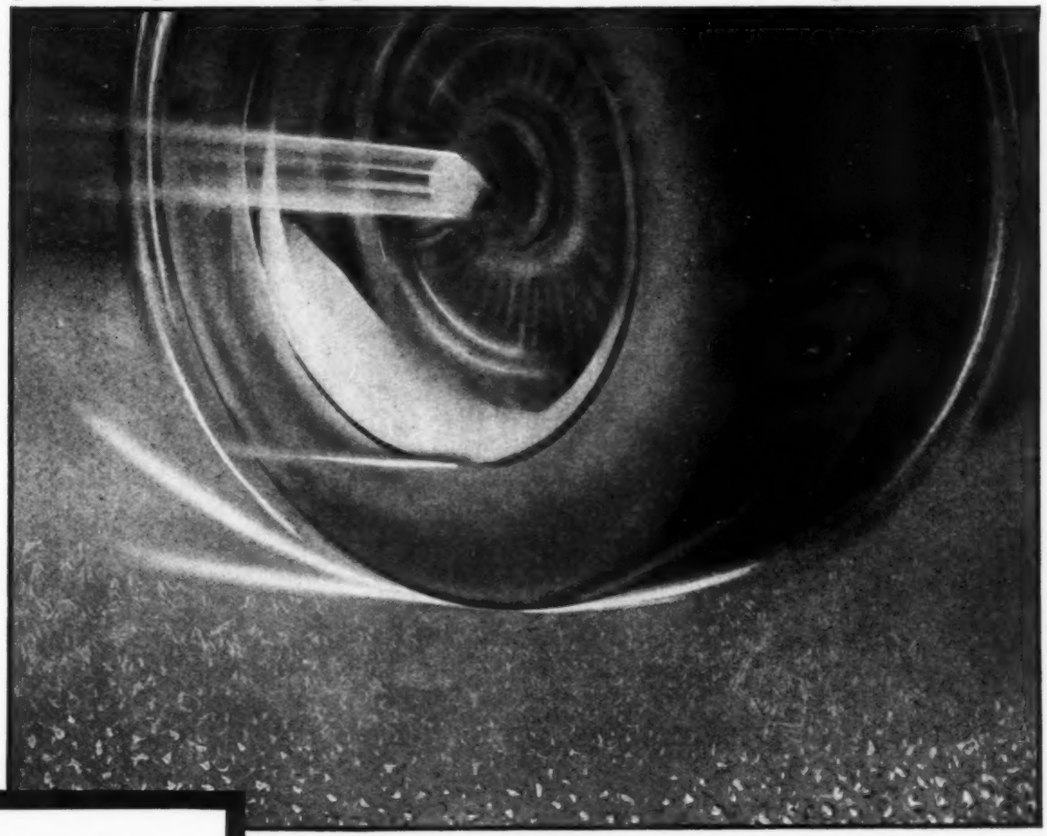
TABLE II.—OIL PENETRATION FOR PERIOD JULY 1, 1934, TO JUNE 30, 1935

1	19.0	166	$921	$139.47	$43.78	$323.33	$419.02
2	14.0	347	758	153.59	81.28	81.28	153.59
3	4.8	349	502	209.69	51.58	419.63	577.74
4	10.0	381	436	250.57	100.64	566.49	716.42
5	15.5	534	689	186.42	91.83	695.66	790.25
6	7.1	539	504	252 76	180.31	782.91	855.36
7	19.0	541	523	286 26	233.84	419.26	471.68
8	8.2	560	499	144.06	110.66	715.53	748.93
9	12.2	590	594	128.81	67.77	376.37	437.41
	109.8	166 to 590	603*	194.62*	106.85*	486.72*	574.49*
10	12.6	650	505	306.11	224.27	606.07	687.91
11	18.7	719	613	161.61	55.06	494.50	601.05
12	19.8	806	617	181.62	129.27	741.53	793.88
13	9.2	1,016	747	196.55	126.61	639.81	709.75
	60.3	650 to 1,016	621*	211.47*	133.80*	620.47*	698.15*

*Average.

"LITTLE EARTHQUAKES"

of every-day traffic start disintegration



Photographic section through welded joint

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Mesh Reinforcing checks it

The primary function of reinforcing in a concrete pavement is to add tensile strength to the slab. The *ultimate* function is to check progressive cracking by holding incipient cracks tightly closed. Mesh fabric is the only type of reinforcing that achieves this ultimate function effectively. Because it is composed of rigidly fixed members of comparatively small diameter, closely and accurately spaced at the mill, Pittsburgh (National) Reinforcing is the ideal reinforcing. The intersections of members, being electric-welded, provide a powerful and unyielding "dead man" anchorage against slippage. The coupon below will bring complete description of Pittsburgh Reinforcing and its use in concrete pavements.

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Pittsburgh NATIONAL Reinforcing

Pittsburgh Steel Co.
743 Union Trust Bldg., Pittsburgh, Pa.

Gentlemen:

I am interested in learning more about the advantages of Pittsburgh (National) Reinforcing.

Name .....

Address .....

TABLE III.—LIGHT MAT FROM PERIOD JULY 1, 1933, TO JUNE 30, 1934

1	8.5	204	$1,677	$212 29	$125.23	$125.23	$212.29
2	8.7	289	2,539	323 65	272.87	714.87	765.65
3	15.0	343	2.165	627.32	558.92	558.92	627.32
4	18.0	369	2,353	214.29	170.03	170.03	214.29
5	18 7	402	1,391	672.08	587.52	587.52	672.08
6	18 0	489	1,607	782 25	718.08	718.08	782.25
7	15.0	504	1,495	502 72	444 35	1,059.35	1,117.72
8	10.0	534	1,113	682.75	575.30	575.30	682.75
9	12.8	560	2,064	475.86	310.70	597.57	762.73
10	9.8	572	2,577	306.09	215.89	215.89	306.09
11	9.8	597	1,834	284.56	240.86	240.86	284.56
	144.3	204 to 597	1,892*	462 17*	383.61*	505.78*	584.34*
12	9.5	620	1,891	768.14	667.59	667.59	768.14
13	15.0	634	1,987	606.18	340.98	340.98	606.18
14	14.0	640	2,384	305.86	239.89	239.89	305.86
15	10.0	647	1,699	225.00	71.27	482.21	635.94
16	13.0	787	2,136	425 35	247.65	737.65	915.35
17	20.5	801	2,587	451.65	400.61	400.61	451.65
	82.0	620 to 801	2.114*	463.70*	328.00*	478.16*	613.85*
18	14.4	1,023	1,437	540.81	496.16	999.16	1,043.81
19	11.2	1,054	1,914	296 25	158.24	575.77	713.78
20	17.4	1,140	2,435	497 96	433.88	952.88	1,016.96
21	5 3	1,154	2,527	224.11	145.26	145.26	224.11
22	13.0	1,257	937	546.23	446.98	1,379.69	1,478.94
23	13.5	1,270	1,808	347.39	225.93	532.69	654.15
24	7.0	1,501	2,550	602 75	522.70	702.20	782.25
25	15.0	1,604	3,042	246 43	143.59	662.59	765.43
26	10.5	1,616	2,100	114.38	44.60	44.60	114.38
27	7.5	1,719	2,637	536.59	463.52	604.02	677.09
28	15.8	2,028	1,380	529.56	474.62	474.62	529.56
	130.6	1,023 to 2,028	2,070*	407.50*	323.23*	643.04*	727.31*

*Average.

costs as much as traffic volume. When considered in connection with soil classification and drainage, rainfall is important. In eastern Kansas, the topography is rolling, moist soils fall within the A-7 classification and over this region the average annual precipitation varies from 30 in. to more than 40 in. Outcroppings of rock which intersect grade lines will cause trouble unless the proper drainage is provided. Many mat failures may be attributed to rock ledges and a rainy spell. The best method of repair seems to be to subgrade at least 6 in., remove the ledge and back fill with crushed stone ranging in size from 2½ in. down. Trench drains alone have not proved satisfactory.

Conclusion.—Kansas has adopted the following practice where bituminous surfaces are involved.

Heavy mats are used on roads which carry more than 600 vehicles daily. Mats are constructed with crushed stone and cutback asphaltic oil if available. All weak subgrades are stabilized with crushed stone and drained.

Light mat construction has been discontinued.

Oil penetration is used where the subgrade and drainage are good and traffic is less than 600 vehicles per day. This method is also used as a temporary dustless, all-weather surface and as a base preparation for heavy mat construction.

It is most difficult to design a bituminous surface without considering traffic, rainfall and topography. The original cost of construction is not reflected in maintenance costs until heavy mat construction is considered. This is the oldest type of bituminous surface in Kansas and to date maintenance costs have been considerably lower than those of other types. A year ago the highway department constructed three test sections of heavy mat construction using crushed stone and cutback asphaltic oil. To date results have been gratifying and there is now under contract 118 miles of heavy mat surface. The subgrade has had as much attention as the mat and it is believed that maintenance costs will be decreased. It is believed that our bituminous surfaces in Kansas have been economical and that the benefits of dustless, non-skid, all-weather surfaces have more than offset maintenance costs to date.

A paper presented at the 1936 Highway Conference at the University of Colorado.

▼

HIGHWAYS IN CHINA.—Figures of the Bureau of Roads of the National Economic Council indicate that at the end of 1935 there were 55,960 miles of highway available for motor transport within all of China, including China proper, Mongolia, Manchuria and Tibet. It is estimated that there are approximately 46,600 miles in "China Proper" (that is, exclusive of Manchuria, Mongolia and Tibet) open to traffic at the end of 1935, of which 621 miles are high type surface; 12,427 miles low type and 33,553 are earth roads, the latter being impassable during rainy weather.

▼

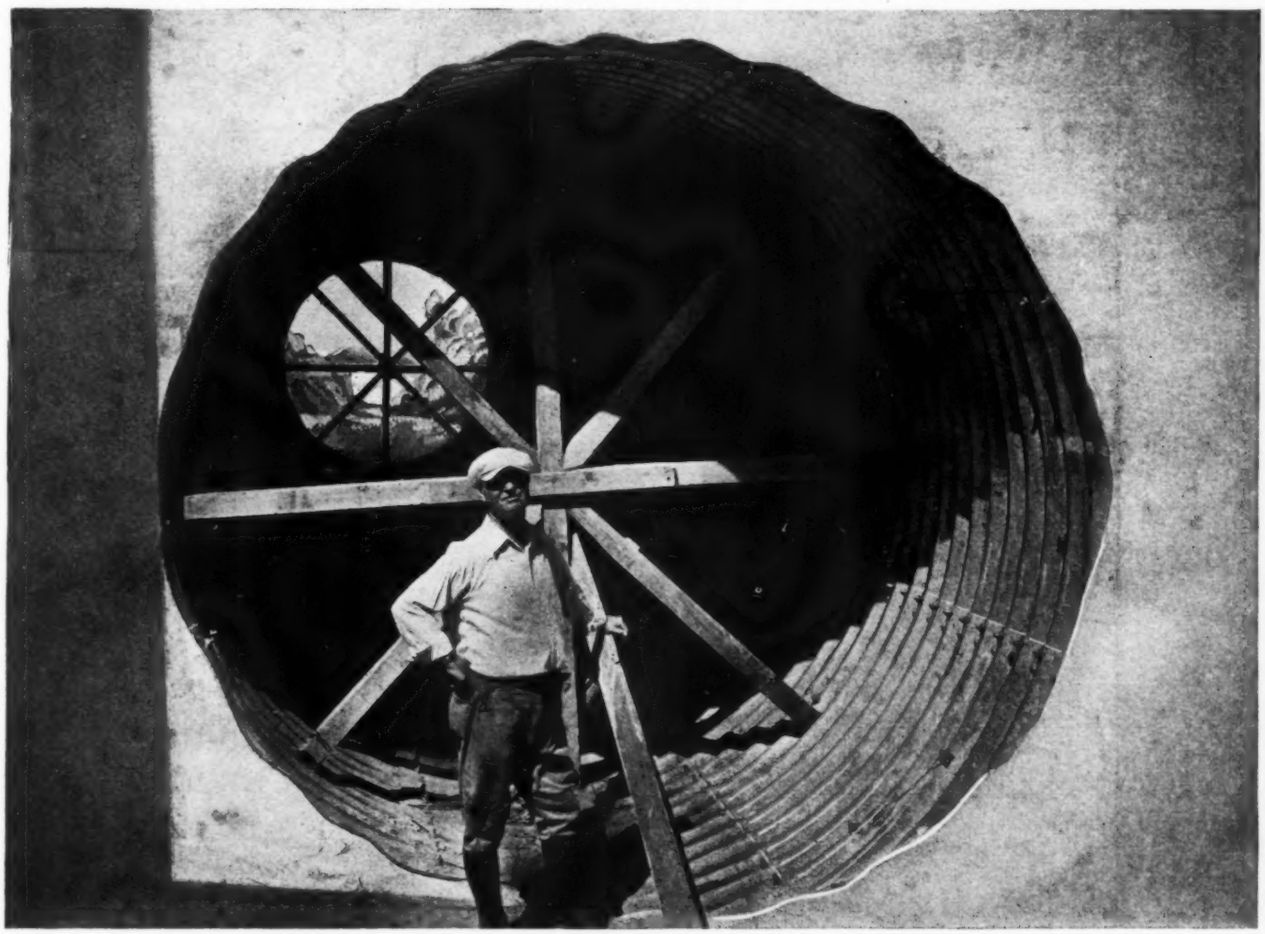
A CORRECTION.—Our attention has been called to errors in the article "Bituminous Soil and Base Stabilization" in the February issue. The third sentence in the last paragraph of the first column on page 58 should read: "After solidification and removal from the water, this drop is easily wetted by water, only on the surface first in contact with the water, whereas," the portion which originally solidified in air is easily wetted by oil. Also in many cases throughout the article the term "absorbed" was erroneously used for the term "adsorbed."

▼

ROAD WORK IN SWEDEN.—For the repair and maintenance of Swedish roads and for the construction of new highways, 137,210,000 kroner (kroner = 27 ct.) were spent in 1935, as compared to 146,770,000 kroner the year before, and 109,370,000 kroner in 1933. The biggest item was for maintenance, which amounted to 56,000,000 kroner, or nearly 6,000,000 kroner more than in 1934.

No Breakage

EITHER IN TRANSIT OR ERECTION



AND this means a lot to engineers and contractors who want no costly delays . . . particularly on *time-contracts*. The ease and speed of erection is another important economy factor.

Further, there is less excavation with *American* Sectional Plate construction, because of the smaller wall section. There are no elaborate forms to build and remove, and shoring is rarely necessary. And so accurately are the plates formed that they literally "fall together" and any type of labor can easily and quickly assemble them, because of symmetric corrugations and uniform bolt holes. Only a few inexpensive tools are required, and specially designed bolts help speed up all erection.

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UMATILLA COUNTY, OREGON CUTS COST OF FARM-TO-MARKET ROADS

THREE years ago Umatilla County, Oregon, began a program of permanent improvement for county farm-to-market roads. Prior to that time there had, of course, been efforts at improvement, but the new program called for a minimum of 30 miles of graveling, part of which was to be oil mix and the rest traffic bound macadam.

Bids from commercial stone quarries made it obvious that with the funds available and the annual requirements for maintaining 3,000 miles of roads and 2,000 bridges, the contemplated program was too ambitious. Nevertheless, because it was a policy of the county to use force account work wherever practical, a survey was made to determine the possibilities for using a portable crushing and screening plant and cutting the cost of hauling to the job while eliminating the porfit of the commercial producer. Upon the completion of the survey and a careful analysis of portable plants, the county purchased a self-contained unit consisting of a 9 in. by 40 in. primary jaw crusher, and a 4 in. by 40 in. secondary jaw crusher for the fine material required on highway work.

For the full two years the plant has been in operation the crusher averaged 45,000 cu. yd. of rock at a cost of 45 ct. per yard in bunkers. This figure includes shooting the rock, cost of oil and gasoline, grease, etc., labor of six men and a liberal depreciation. In good rock the average hourly yardage is from 35 to 40 yd. Basing the estimates of savings on the quoted prices of the commercial producers, the yardage crushed during the past two years has fully paid for the machine and the plant is now netting the county a profit.

Because of the availability of good non-porous rock of the proper hardness, the plant is moved frequently to reduce the length of truck travel. The time required for moving and setting up for operation is about 24 hours on the average haul.

Beginning as early as possible in the spring, the crusher is put to work, and stock piling with a small Badger shovel builds up a reserve for the spring work before the frost is out of the ground.

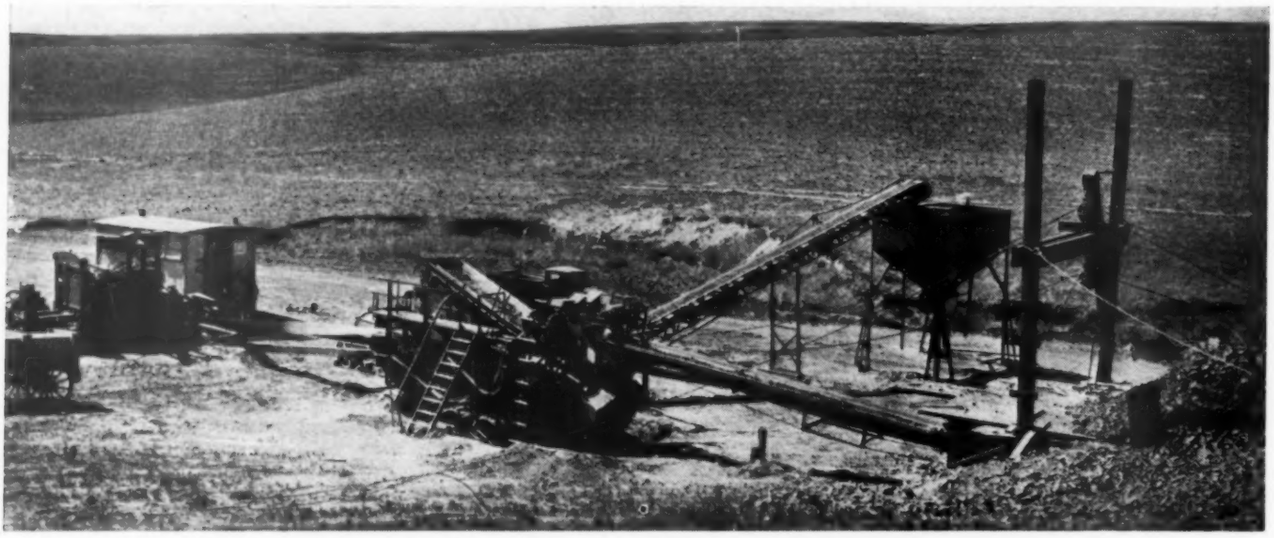
The Portable Crushing Plant on Its Way to a New Location.

By the middle of April of this year the county had produced 20,000 yd. of material, part of it for surfacing the Pendleton Airport runways which are oiled macadam, and part to be placed on a county road not far from the city of Pendleton. The balance will be loaded from stock piles for use on other highways.

The roads are generally maintained by motor graders, of which they have four machines. With these the entire system is covered once every six months, and the major feeder lines once every three months.

Each year, in addition to regular maintenance, 30 to 40 miles of highway are reshaped, drained and graveled, so that over a not too distant period the entire system will have well stabilized roads not subject to the severe action of spring thaws and rains which still make some of the highways difficult during the early months of the year.

This year the county is employing about 80 men under the supervision of Mr. R. J. Wheeler, County Roadmaster. In addition to these there are about 75 WPA workers who are employed on three projects.



Austin-Western Crushing and Screening Plant in Operation near Pendleton, Oreg.

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HIGHWAY ACCIDENTS; THEIR CAUSE AND THE REMEDY

By JOHN W. WHEELER
Member State Highway Commission of Indiana
Indianapolis, Ind.

THE ever-increasing upward turn of the death and accident curve as pertains to highway traffic causes highway engineers to ask over and over again, what is the cause, and how may it be improved. Because there has been so much written in the last few months concerning deaths and injury on the highways, I will merely make the following short statements of facts obtained from data of the Association of Life Insurance Companies. We killed in 1935 on the highways in the United States 36,100 people, which figure is the highest of any year on record. During the 10-year period from 1925 to 1935 we had an increase in deaths of 67 per cent. In that same 10 years cars only increased 31 per cent and our population increased but 11 per cent. In the last 15 years we killed 400,000 people and injured 10,000,000 people, and we find today that when we add up the economic cost of motor accidents, figuring lives, property damage and hospital bills, we are spending more in this killing than the entire school system of the nation costs.

Speed Prime Factor in Accidents.—Let us consider the cause of so many fatal accidents. They can be charged up against many factors, such as reckless driving, carelessness, unqualified drivers, faulty vehicles, poor roads, and speed; and in my opinion speed is the prime factor of practically every accident. In my opinion it plays the major role in all fatal accidents.

Only a few weeks ago in Indianapolis on a new 40-foot pavement the driver of one car left his lane and drove across the pavement, striking another car being driven in its proper lane. There were seven people in the two cars; six were killed instantly, and the seventh still lingers in a state of semi-consciousness. Because this highway was as safe as we could build it, I examined the testimony at the coroner's inquest as given by the two witnesses driving other cars at the immediate time and place of this accident. They testified that one car was going 65 miles an hour and the other 45 miles an hour, and that the two cars met head-on. It was easy to get the weight of each car, knowing its model, and easy to estimate the weight of the passengers in each car. Remembering Newton's second law of physics (force equals mass times acceleration) it was likewise easy to figure the force of this impact. When these two cars met head-on over 600,000 foot-pounds of work was created. Naturally people cannot live in an impact of this magnitude. This is going on, of course, in practically every major accident.

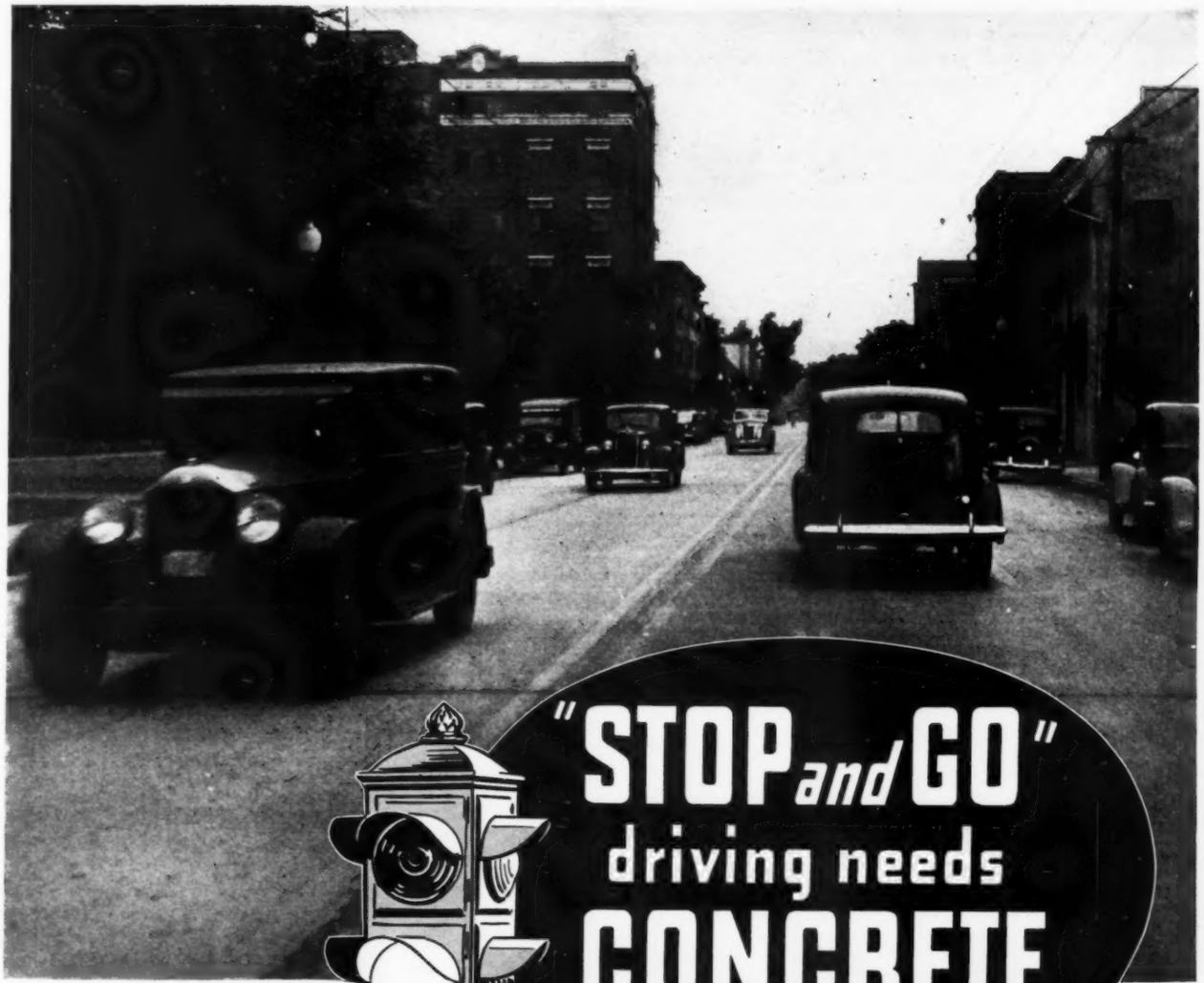
Co-ordination of Design of Motor Car and Highway.—In my opinion the time has come when we must co-ordinate the design of motor cars and highways, agree on a sensible speed in miles per hour, and then design both the highway and the car for that speed. We have been prone to thinking of the automobile as a unit of transportation when in reality it is but half a unit of transportation and the highway is the other half, and in my reasoning these two component parts of the transportation system must be designed together. Since the advent of the automobile the automotive designer has designed his vehicle and the highway engineer has designed his track without any knowledge of what the other one is doing, and merely hoping that they will fit.

Thirty-Mile Roads and 80-Mile Cars.—The trouble is that we bring out new models of motor cars each year and the life of the average motor car is but five years; while highways, properly constructed, will last 20 years. Therefore we find 1936 cars on 1920 roads which are not capable of the speed that the new car develops. The 1920 road was all right for the 1920 car operated at approximately 30 miles per hour over the country highway, but when we try to put an 80 mile per hour car on the 1920 road it fails utterly. Has this folly existed in railway practice? No, it has not. The designers of the new streamline trains knew exactly what these trains would be asked to run over, the amount and kind of ballast, the nature of the ties, the weight of rail, the amount of horizontal curvature, the amount of super-elevation and the gradient of the track. The builders of rolling stock and the builders of track worked together to the last detail.

I maintain that some sensible speed per hour must be agreed upon by both the automobile designers and the highway designers. We will all admit without study that 25 miles per hour is perfectly safe and we know from Sir Malcolm Campbell's experiments at Salt Lake that it is mechanically possible to drive a car 300 miles per hour. Some place between 25 miles per hour and 300 miles per hour there is a sane, sensible, economical speed which cars and highways should be designed for. In a recent interview with Mr. Alfred P. Sloan, President of the General Motors Corporation, Campbell stated that on highways he did not drive over 55 miles per hour because he felt that beyond that speed it was unsafe.

Speed Gained and Price Paid for It.—Let us ask ourselves whether this great increase in speed has benefited society sufficiently to pay for 36,100 lives in 1935. Was the speed that we gained worth the price we paid? In my opinion the speed we gained was worth to us very little and the price we paid was extremely dear. I often relate of the fastest car that ever passed me on the road and tell how that young man went around me with terrific side-sway due to his speed, and in my own mind I was confident he had either robbed a bank or learned his mother was dying at some distant hospital, and to my great surprise when I arrived at a roadside lunch-stand some four or five miles up the road I found him calmly sitting on the running board of his car eating an ice cream cone. Doubtless if we had a way of determining where these speeders were going, we would often find that they had no definite objective at the end of their trip. The increase in speed has not benefited to the extent it has cost.

Highway Industry and Motor Industry Must Act Together.—The highway industry and the motor industry



"STOP and GO" driving needs CONCRETE

Since 1931, Indianapolis has forged steadily ahead toward the completion of a farsighted program of street modernization. Over 250,000 square yards of new concrete resurfacing and widening are now in service.

TRAFFIC on streets such as this is measured in millions of car miles annually—and millions of car stops. Time after time every motorist stops and starts in response to signal lights, stop signs, traffic interruptions and emergencies. The ability to make these stops swiftly, surely, with least possible skidding or slipping, is an essential of safety.

Concrete streets have a uniformly *gritty surface* that offers maximum traction under any weather conditions. Tires grip and hold; skidding is reduced to a minimum.

The even contour of concrete streets adds further to their safety, and concrete's light-gray matte surface improves visibility at night.

A lift to your safety program is the priceless "plus" value of concrete—the pavement that costs the least to build and maintain for a given load carrying capacity—the pavement motorists and taxpayers overwhelmingly prefer.

PORTLAND CEMENT ASSOCIATION

Dept. A6-28, 33 W. Grand Ave., Chicago, Ill.

which make up the new transportation system must act together in co-ordinating its designs or congress and state legislatures will act for us, and we will have the statute books on the drafting table along with the slide rule. This should never come. The two groups of engineers should handle this without legislation. To build roads safer and more modern will cost a great deal of money, but let us consider this new transportation system of ours for a moment. We pay $700 or $800 for a new automobile when the average gasoline and motor vehicle tax for the whole nation was only $34.46 per vehicle last year; $800 for the car and $34.46 for the track to run it upon. To me this seems out of balance. If for instance the car owner had no garage and his neighbor had an extra compartment which he rented for $4 a month, he was paying $48 a year for a simple roof to shelter his car, and only $34.46 for the 3,000,000 mile highway system of the United States over which he could run his car. Either garage rent is too high or we are not paying enough for the construction and upkeep of this great highway system. Before we have a safe and convenient highway system we will have to pay more money for it, for when we balance the cost of the track against the cost of the rolling stock I think we should be willing to pay more for a better track. I believe earnestly that the co-ordination of design between these two component parts of our new rubber tired transportation system will do more toward breaking the death and accident curve down than any other method we have tried or suggested. It must come or we can expect more deaths, more suffering and more damage.

▼

Bituminous Running Strips on Old Gravel Roads

EXPERIMENTAL bituminous running strips for old gravel roads have been tried out by Country Roads Board of Victoria, New South Wales. The experiences are described as follows by L. F. Loder, Chief Engineer, in the annual report of the Board for the year ended June 30, 1935:

Following information received on the development of penetration macadam running strips on old gravel roads in Rhodesia, it was decided to experiment with a modification of this idea, on old 15-ft. graveled roads on the Murray Valley highway near Rutherglen. On these roads in the north of the state, subject to comparatively light traffic, usually under 100 vehicles per day, the unsurfaced graveled roads have many unsatisfactory features. These parts of the state are dry and warm for most of the year; consequently the dust nuisance is considerable, and these dust clouds have been the cause of accidents. Again, the wear on the road is fairly heavy and corrugations form rapidly. Cutting of these corrugations necessarily produces a fairly deep mulch which in a dry season causes still further loss of material and some danger to traffic. If the corrugations were not regularly removed, the roads would become extremely uncomfortable. On the other hand the cost of re-shaping to a standard cross section and sealing, say 16 ft. to 18 ft. wide, is heavy. It was therefore decided to put down a section consisting of four types of experimental seal. On two lengths of ¼ mile each, strips approximately 2 ft. 9 in. wide, separated by a space of 2 ft. were sealed. On one of the two lengths the edges of each strip were reinforced by digging a shallow trench about 1½ in. deep and filling with premixed material, on the other strip no edge preparation of any sort was carried out, the strips being primed and sealed in the ordinary way. Two other lengths, each ¼ mile in length and continuous with the previous two, were sealed 7 ft. 6 in. wide, one length having reinforced edges, the other being an ordinary double coat seal. The section in question carries about 150 vehicles per day, and is immediately adjacent to the town of Rutherglen. This section carries rather more traffic than the type would be considered suitable for, and on one fairly sharp curve no widening was attempted, the whole of the traffic leaving the strip and "cutting" the corner, thus there was a severe test of the edges at this corner, which occurred on the 7 ft. 6 in. unreinforced edge strip. The experiment has been entirely satisfactory; there has been no maintenance whatsoever on the sealed surfaces or edges in the seven months, including a very wet winter, during which traffic has been using the road. The gravel between the two separate strips, however, got quite rough, and its maintenance would appear difficult.

As a result of this experiment, it was decided in future to adopt a width of 8 ft. without any attempt to reinforce the edges. The lack of any trouble at the edges, even at the curve mentioned, is probably due to the fact that the whole of the 8 ft. sealed was on a very well consolidated portion of the road with sound gravel immediately adjacent, whereas on the ordinary road pavement sealed full width, the edges are seldom consolidated owing to the small amount of traffic using the edges before sealing, and the adjacent material is usually earth, which does not give adequate support when wheels run just outside the sealed section. Many old graveled roads have a reasonable thickness in the center, but excessive camber for sealing the full width. For passing purposes this camber is seldom sufficiently steep to be troublesome, and it is not desired to encourage traffic to use the gravel edge of the road on these light trafficked roads; consequently the cost of sealing this type of road 8 ft. wide would be much less than half the cost of a 16-ft. pavement, which would need to be reconstructed to its full width, involving the building up of shoulders as well. With the development of traffic, the building up of the sides of the road, and the widening of seal coat will be a simple matter.

▼

DRIVEWAY CONSTRUCTION.—To help the homeowner build his private driveway or to contract for it, the U. S. Bureau of Public Roads has prepared a pamphlet, "Construction of Private Driveways." Drives of stone, gravel, bituminous material, concrete and brick are described. Drawings and photographic illustrations show several kinds of "ribbon" surfaces and full-width surfaces with dimensions. The pamphlet includes tables for rapid estimating of quantities of materials. Copies may be obtained from the Bureau of Public Roads, Washington, D. C.

▼

TURN-OUTS FOR RURAL MAIL BOXES.—A new policy of building turn-outs to rural mail boxes on all new construction has been announced by the Michigan State Highway Department. The turn-outs for the present probably will be of gravel construction, but oil aggregate may be used on roads where that type of construction is planned. The distance of mail boxes from the pavement will be standardized in the future at 1 ft. from the edge of the shoulder. The co-operation of postal authorities will be sought in standardizing the height of the mail boxes.

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Metal Accessories for Highway Construction

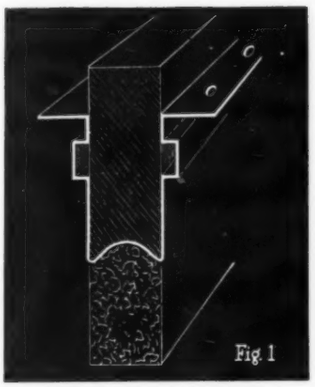
Fig. 1

FIG. 1

illustrates the metal housing for the fibrated asphaltic joint showing control of oozing of upper structure. The base is prepared from a non-oozing material.

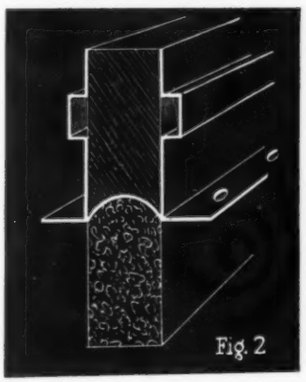
Fig. 2

FIG. 2

illustrates a fibrated asphalt top showing metal escape containers with a fibrated asphaltic top and a sponge-rubber, cork-rubber or fibre board base. The structure has an intermediate seal.

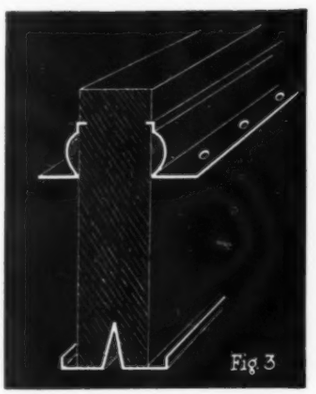
Fig. 3

FIG. 3

illustrates a combination seal imbedded in fibrated asphaltic top and the escape apertures as well as the seal absolutely controls the fibrated asphalt flow. The base has a copper seal.

FIG. 4

illustrates an extruded fibre mastic product provided with grooves for the metal accessories used in connection with flow control. Escape dowel locks and supports and upper escape and seal combination control oozing tendencies in this joint. The metal forms contribute to the rigidity of the joint and afford a simple economical means toward a positive seal. The means of properly housing the dowel bars so as to hold the dowel bar in rigid position while the concrete is being poured is effective and certain.

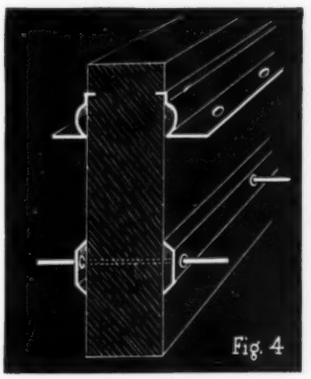
Fig. 4

FIG. 5

illustrates an upper seal which can be utilized with a backing board or with a prepared joint filler in which the joint may be poured or filled and a positive seal formed thereover. 5a-5b departures from 5.

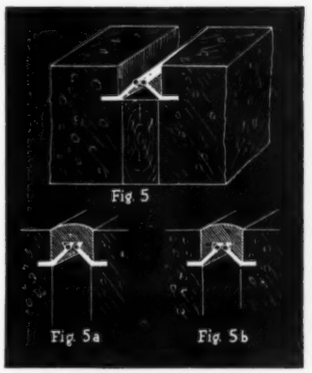
Fig. 5

Fig. 5a Fig. 5b

FIG. 6

illustrates a separate metal housing seal.

FIG. 7

illustrates a metal form for the base seal.

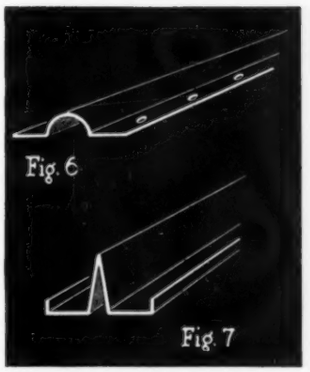
Fig. 6

Fig. 7

NOTE: All the benefits of a metal cushion joint are obtained and in addition a waterproof filler and seal with greater flexibility at lower cost.

In conjunction with the above, we furnish extruded fibrated asphalt material with the fibre content in greater relation to the asphalt content so as to furnish some resiliency. This material comes grooved with a suitable affixing of dowel supports and escape cushions.

We also furnish extruded sections such as curb cushions; bridge plank, mineral surfaced, standard and ribbed; and our metal accessories in conjunction with highway and bridge construction.

We specialize in extruded forms to meet various engineers needs.

SERVICISED PRODUCTS CORP., 6051 W. 65th St., Chicago

Observations by the Way

By A. PUDDLE JUMPER

¶ Was it a good party or was it a good party? The Dalrymple Equipment Co., Inc., Amory Miss., was the host to over two hundred road builders of Mississippi at Arch Dalrymple cottage south of Amory. Contractors, engineers and equipment and materials men were guests. Director Kenna and Commissioner Abe Linker of the Mississippi Highway Commission were contenders for fish eating honors. Abe won. This annual event brings together in good fellowship, sans formalities, the road builders of the State. Ask Walter Froemming of Froemming Bros., Inc., Milwaukee, Wis., how he liked the fish.

• •

¶ Time was when we were glad to reach a gravel road. Time now is when we cuss that same type of road on account of dust, punctures, and chatter bumps. How times change.

• •

¶ Business with one equipment manufacturer of heavy equipment the first four months of this year is 100.1 per cent ahead of the first four months of last year.

• •

¶ Another sign of the return of normal business conditions is the volume of room rentals in hotels. Men are back on the road selling.

• •

¶ I was told that price cutting on standardized heavy equipment has been done in Texas recently. That procedure caused a lot of trouble not so many years ago. It is hoped that the viscious practice will not continue.

• •

¶ Some contractors seem to think the only thing that counts in the construction industry is "Where is the next job coming up?" Seems to me they should think, "How did it happen that this job on which I am working could exist? What factors caused the perpetuation of construction work? What organizational and publication efforts helped to keep the construction industry alive when other businesses were dead? To whom am I indebted, in the beginning, for the opportunity to bid on this job?" These and many other questions some contractors should ask themselves. Too many take the narrow minded viewpoint of their industry.

• •

¶ A tribute to the wide distribution of and universal acquaintance with the Model T Ford was unconsciously given by one highway department by its selection of an old Ford front wheel and the equally familiar 30x 3½-in. tire as a high water gauge

Ford Wheel as High Water Gauge

which would be instantly recognized and heeded by motorists. Mounted on a steel post at the side of a road traversing a flat which stands dry 360 days out of a year, but which is lost under coffee-colored backwater when a nearby river does go out of its banks, this assembly stands guard, the lowest point of the tire set on a level with the lowest point on the highway grade. Then, when the water reaches up on, or nearly covers, the Ford wheel and tire, the motorist, recognizing it, heeds the warning lettered on the sign above the wheel, and is saved a possible wetting, or the temporary disabling of his car in water too deep to be traversed with safety.

• •

¶ If you want to see a nice strip of black top road drive on U. S. 49 southeast of Jackson, Mississippi. If you want to see a nice strip of concrete road drive south of Chicago on U. S. 45.

¶ Those red rambler roses which are planted along the roadside on the west approach to the bridge across the Mississippi River at Memphis are certainly pretty. I vote for more of this beautification.

• •

¶ One good sign of better conditions in the construction field was evident at the May 19 letting in Mississippi. Many contractors, in letters accompanying their bids, said substantially to following: "In the event we are low bidders on more than one project we wish to be awarded only one."

• •

¶ Those notices painted on the roadways in Tennessee just before arrival at a junction point or a school zone are surely fine. After traveling hundreds of miles in other states under poor signing conditions it was a pleasure to run across those junction notices painted on the pavement 250 yards or so ahead of the junction. We suggest signs along the roadside follow within 50 yards stating name, direction, U. S. number and mileage to the next large town or city. Then repeat the signs with smaller towns listed right at the junction. Self illuminating signs are preferable.

• •

¶ We compliment the Hotel Patten of Chattanooga, Tenn., on those electric U. S. 41 signs leading into the city from the south. Only a blind man could lose the way.

• •

¶ How striking those Tennessee steel bridges appear. All bridges are painted with aluminum paint. They are amply wide and strike the eye as beautiful structures.

• •

¶ We suggest that Atlanta, Ga., do something about the traffic problem. The streets are jammed with traffic, apparently going any way and every way. A first class traffic study resulting in boulevarded street recommendations is suggested.

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A NEW, improved tractor built specially for highway and other heavy duty cutting . . . designed and built for easy, fast and economical operation. No special skill required. Ford Model B motor with self starter and standard gear shift. Transporting speed up to 50 miles per hour for quick trips between jobs. Cutting unit detached in 30 minutes.

The ONLY tractor mower with sickle bar driven by an independent motor, (TORO 2 H.P. air-cooled 4-cycle with automatic governor control) with sickle carried on a separate pneumatic tired wheel and which can be operated in a cutting range of 150 degrees (90° above horizontal and 60° below horizontal). Releasing device permits cutting unit to swing back when obstructions are hit. Worm gear lift for full lift and emergency hand lift for quick partial lift.

Write for folder giving full information and specifications.

TORO MANUFACTURING CORPORATION
OF MINNESOTA
3042 Snelling Ave., Minneapolis, Minnesota, U. S. A.

¶ Here is a sign I noticed at a bad curve on a road in Louisiana: "Go slow, you might meet as big a fool as you are."

• •

¶ This is an appeal to city fathers to do something about signing the streets for through traffic through their cities. Through traffic which has never been to the city before, in most cases, gets quite confused and lost in the maze of city streets. This is especially true at night. Luminous signs should be installed to guide the night traveler.

• •

¶ Indiana is making plans to establish a highway department research division at Purdue University. One of the first problems will be a study of surface treatment methods. A director will be selected this fall. Approximately $25,000 will be available for the first year's work.

• •

¶ Georgia's $17,000,000 federal aid has now been made available for expenditure. The political mix-up has been straightened out.

• •

¶ We hope the Alabama Planning Survey will cause a standardization of county administration in the state.

• •

¶ Where is the Governor of Georgia getting the money to run the state? The last legislation failed to pass an appropriation bill. We guess that gas tax revenues or license tax revenues are being diverted.

• •

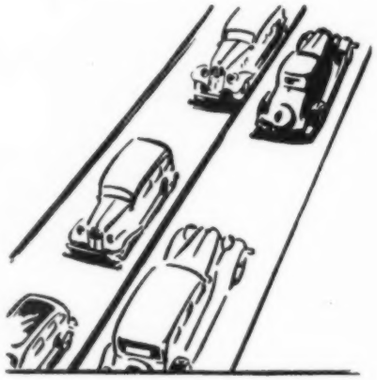
¶ Governor Horner and Director of Public Works Bob Kingery of Illinons were paid handsome compliments by Ray Williams, Secretary, Cairo Association of Commerce, when I was talking with him today. He said these men have done excellent work for southern Illinois on the hard-road highway program.

• •

¶ Why are those signs "State Maintenance Ends" placed on city limits? Provision should be made, legally, whereby gas tax funds pay for maintenance in cities on state and federal routes through those cities and towns. Let's get busy and correct this deficiency. It is not fair to a town or city to make it maintain streets carrying traffic conducted to that street by federal and state highways. Let us get the wheels moving so we can tear down those "State Maintenance Ends" signs.

• •

¶ The Life Line: Truly the center line marking on a highway is as much a life line as one extending from a foundered ship to shore. I wish it had been painted on the center of a road about half way between Knoxville and Nashville, Tenn. Most of this road is excellent, but one strip is a rough stretch without center line.



The Life Line

In the dark of the night I met a big truck rounding a sharp corner. We were both on the wrong side of the road (an accident was averted because I took to the shoulder of the fill) because no center line was marked. In that case a center line could easily have been a Life Line.

• •

¶ That's a good idea that Decatur, Illinois, put into effect on the main route north and south through the city. The pavement was painted off in traffic lanes, several lanes wide, clear through the city.

• •

¶ Another good idea to help the night driving motorist is those reflecting buttons nailed at the top on the side of guard rail posts on curves. Only curves where speed has to be reduced to 40 miles an hour or less are provided with buttons. I think that is an excellent idea. The sharp curves do not get a chance to jump out of the darkness ahead when you are traveling 50 and 55 miles an hour. The curves show up a long way a head and the guard rail is clearly defined by these reflecting buttons as you round the surves. If we only had some cheap method of producing this same effect on centerline and edge marking it would be a big help to driving and avoid traffic accidents.

• •

¶ Night driving in Southern Illinois is more hazardous than in the north because of laxity in "Highway Courtesy."

• •

¶ The best route to the south through Cairo from Chicago is U. S. 45 to Effingham and Illinois Route 37 from there to Cairo. It's all new and most railroad grade crossings eliminated. I understand that drivers make the trip over this route in six and one-half hours. It took me eleven hours over U. S. 66 and Ill. Route 51 from Chicago to Cairo. This route has a great many railroad grade crossings.

• •

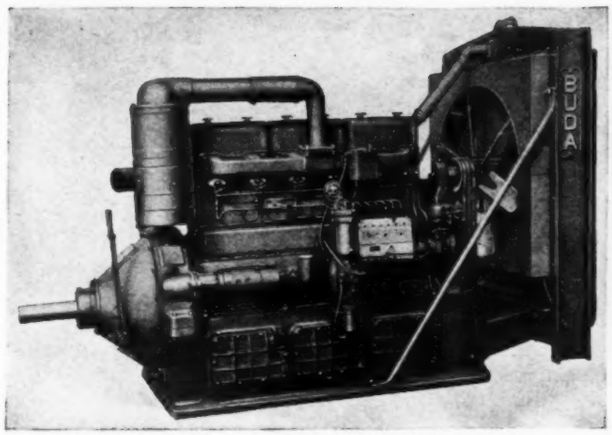
¶ John W. Wheeler, Indiana Highway Commissioner, and also a civil engineer believes that speed is the major cause of accidents. I believe he is partially mistaken. Speed improperly controlled may be so let's design and improve our roads and streets as part of a transportation system. Then let's increase speed. Automotive engineers have made big strides in building safety into the vehicle. Let highway engineers build more safety into the trackage and its appurtenances. I believe 55 or 60 miles an hour should be a fair speed to expect on smooth highways. That, however, is out of the question until our 40-mile-an-hour curves are corrected.

• •

¶ Truck trailers that transport these new automobiles over the highways are too wide. They take up the full width of a traffic lane. When the driver veers to the left a mite the trailer whips over into the lane for opposing traffic. It's dangerous. "There ought'a be a law."

• •

¶ Why is it when your car needs gas or you feel hungry, the filling stations, both gas and hot dog, are always on the opposite side of the road, necessitating cutting across traffic to reach them?



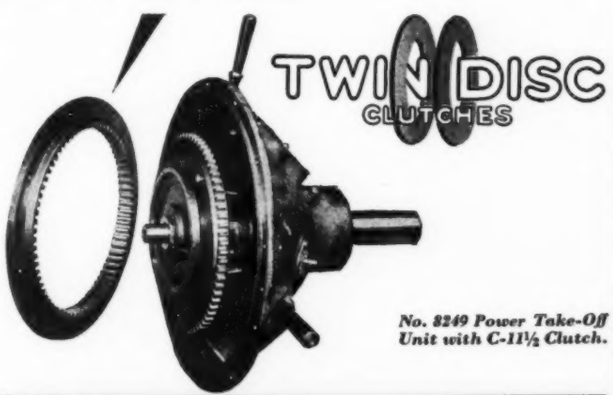
The new Buda-Lanova Diesel Model 6-LD-909 . . . a 6-cylinder, 4-cycle, solid injection engine; 5½ x 7 in., 909 cu. in.; 178 hp. at 1500 rpm, 156 hp. at 1200 rpm.

WHY BUDA Standardizes ON THE TWIN DISC CLUTCH

Like other Buda Engines, the latest addition to the industrial line, the "909" 6-cylinder Buda-Lanova Diesel, is Twin Disc equipped.

And the reason is—"While the use of the Twin Disc Clutch *did* enable us to simplify the design and construction of this unit, as well as others * * * the Buda Company has *standardized* on Twin Disc Clutches *primarily* because of the reputation of this clutch."

It took nineteen years of specialized experience and engineering research to build that reputation. The makers of Twin Disc Clutches intend to keep it. *Write* for specific recommendations on your clutch problem. Engineering data on request. *Twin Disc Clutch Company, 1340 Racine Street, Racine, Wisconsin.*



No. 8249 Power Take-Off Unit with C-11½ Clutch.

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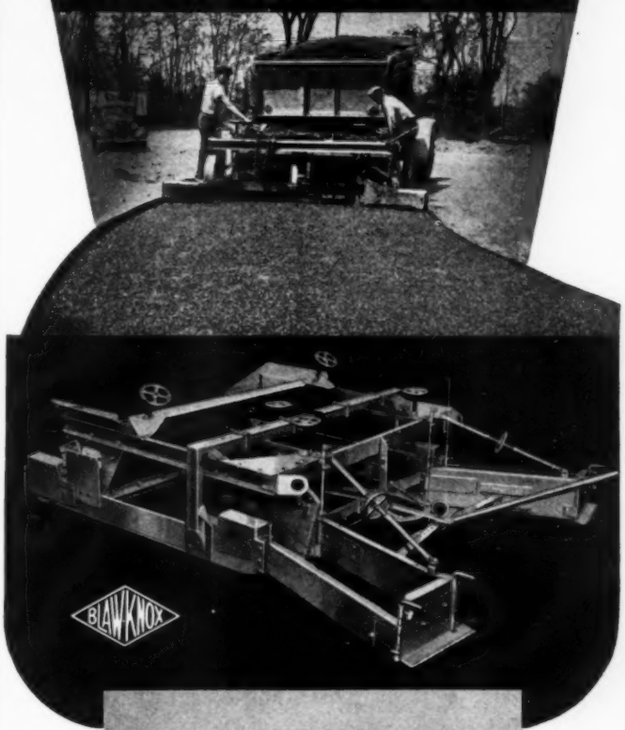

The Blaw-Knox ROAD FINISH-SPREADER will spread and finish stone or gravel; hot or cold asphalt—one to fifteen feet wide—half a road at a time. Will lay varying widths on curves fully or partially banked — *with one machine at a fraction of the usual cost.*

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BLAW-KNOX Road FINISH SPREADER

EDITORIALS

Signing Highway Routes

DRIVING at night is not uncommon. Neither is getting on the wrong road or losing time keeping on the right road in some states. Many states would do well to put signs along their roads to guide the night traveler.

On a recent trip we went through town after town not knowing its name and having no way to find out except to stop and ask a native. In the wee hours of the morning this is not possible. They start rolling up the sidewalks in some of those towns about 9 p. m. With unmarked roads coming and going, crossing and V-ing off, the night driver is bewildered and follows hunches.

Let us suggest to the highway commissioners of some states that they spend the summer in the North Woods of Wisconsin and try to get lost. All bad curves up there are well marked with warning signs. In states we could name one must be forever "on guard" to prevent a curve from ditching him. The new road locations, are usually different. Those are well laid out and plenty of sight distance provided. But it is suggested that other roads might be investigated and signs erected.

▼

Modernize the Highways

SAFETY on the street or highway is not alone the responsibility of the motor vehicle driver. The road or street itself is a contributing factor. Were we to recommend that speed governors be placed on all automobiles cutting the speed down to 50 miles per hour, we would be faced with the fact that 75 per cent of all accidents happen at a rate of speed lower than 50 miles per hour. Were we to try a stunt of painting crosses on all cars involved in accidents we would be confronted with the fact that there are several drivers for almost every car and that many times it is the fault of the highway or driver and not the car when an accident occurs. Further, in comparing rural and urban statistics we learn that the rate of death at rural intersections in 1935 was 122 per cent greater than at city street intersections, also, the rate of death on highways was 183 per cent greater than between city street intersections. One outstanding figure regarding accidents last year is that the rate of death per automobile-train collision was 565 per cent worse than the average of all accidents combined under all conditions of road location. So what?

So modernize the highway.

Here are a few suggestions, some of which were taken from a folder published by the Thew Shovel Company:

1. Wider highways.
2. One-way traffic lanes.
3. Wider and more solid shoulders and ditch elimination.
4. Railroad grade crossing elimination.
5. Clover leaf highway crossings.
6. Non-skid road surfaces both general and at grade crossings.
7. Elimination of sharp curves, and widening and banking curves.
8. Elimination of blind spots and widening of roads at road intersections.
9. Widening of highways at top of hills where sight distance is less than 700 ft.
10. Sidewalks for pedestrians.
11. Underground and overhead crossings for pedestrians.
12. Elevated highways in cities.
13. Highways around cities and towns.
14. Widening of bridges and culverts.
15. Reduction of steep grades.
16. Illumination of highways.
17. Self illuminating traffic lines, markers and signs.
18. Adequate signing.

These are just a few of the many tasks involved in a modernization program. The motor vehicle manufacturer is bending his energies toward building safety into automobiles. Modernization will build a degree of safety into roads and streets.

▼

Easing the Way from the Diploma to the Job

AS a measure for helping the young graduate secure a job, the College of Engineering of the University of California holds a series of conferences with the graduating class, with voluntary attendance, for the purpose of preparing the student for the transition from the directed life of the university to the life career, in which he will more or less have to direct himself.

The course, as it has been called, covers the handling of personal finances, insurance, employer approach, employer psychology and other items which may be considered more or less extraneous to the actual classroom curriculum. In addition the department keeps private files touching on the fitness of the student for various types of engineering work. These files classify leadership or the lack of it, application, personal appearance, cooperation with fellow students and faculty, and other collateral factors touching on fitness from the standpoint of personality as well as technical ability.

In the conferences each item, such as "Job Seeking," "Insurance," "Family Financing," is taken up one at a time and thoroughly considered. In toto the department has assumed the form of a particularly expert personnel office, and its findings are at the disposal of all inquiring employers. It exercises the greatest caution in recommending graduates for jobs, building such recommendations upon its own research into the fitness of the individual.

PAGE traffic TAPE

• Motorists favor Traffic Tape because these resilient bands of steel wire stop cars with a cushioning action. This action not only protects the life of the motorist but assures less damage to his car.

A DEEP ravine beyond the unbanked shoulder of this busy highway was a constant and serious hazard to motorists—until four staunch bands of Page Traffic Tape formed a safeguard for human lives and cars. In less dangerous situations three bands, even two, are sufficient protection. With Page Traffic Tape the motorist secures more miles of safety, the taxpayer spends fewer dollars to provide it. Contractors and highway engineers prefer Page Traffic Tape because of low cost erection and maintenance—because of flexibility in action and application. Write for samples. They are sent upon request.

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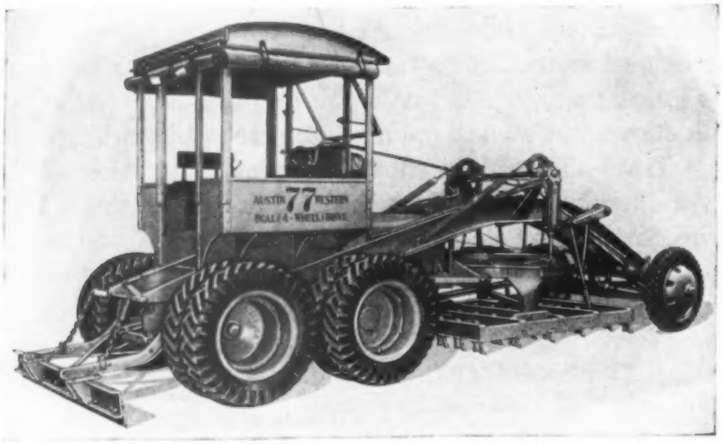
NEW EQUIPMENT AND MATERIALS

New Black Top Scarifier by Austin-Western

A new scarifier for reworking oil treated gravel and macadam roads has been announced by the Austin-Western Road Machinery Co., Aurora, Ill. It consists of a 31-tooth unit, mounted in place of the blade and standard scarifier attachment.

The depth of cut is controlled hydraulically from the operator's platform and either end of the scarifier can be raised or lowered independently. This permits the operator to operate with all teeth horizontal with the surface or set the teeth so that the front rows barely scratch the surface, while the rear teeth carry well into the material.

An adjustable blade set at the rear of the motor grader



New Austin-Western Scarifier

makes it possible to respread the material and windrow the excess in either direction. This latest development is a result of the greater weight and power of the modern motor grader, and for this reason the manufacturers offer this unit for use with the "77" Senior Dual (8 tire) Drive only.

Rigid control is assured by the use of hydraulic controls and ball and socket joints at all connecting points. The standard Austin-Western anti-chatter device holds the circle to the draft beams and prevents all play in operation.

▼

A New "Caterpillar" Diesel Auto Patrol

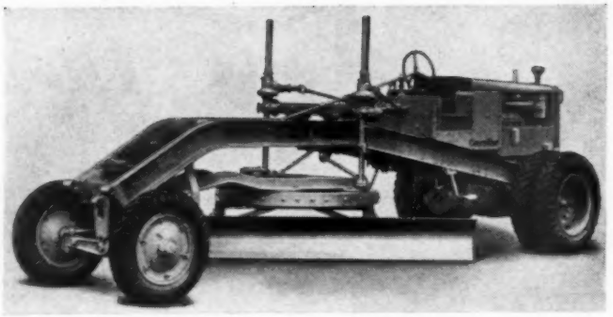
The Caterpillar Tractor Co., Peoria, Ill., has announced the No. 10 Diesel Auto Patrol, the second road maintenance machine in the company's line with a compression ignition engine. The new unit is powered with the same 4-cylinder, 4-cycle Diesel engine used in the RD4 tractor. This power plant, with a 4¼-in. bore and 5½-in. stroke, develops 44 h.p. at governed speed of 900 r.p.m.

The new model is available with either tandem or single drive, according to the announcement. 7.00-20 tires are standard equipment on the front wheels and 11.25-24 low pressure tires are furnished on the rear wheels of the tandem drive model while the dual rear wheels of the single drive machine carry 9.00-24 tires. 12-ft. blades are standard equipment on both machines.

Full power control is retained in this latest model. All operating controls of the blade and scarifier are accomplished through power control levers grouped directly in front of the upholstered operator's seat.

With the announcement of the No. 10 Diesel Auto Patrol, the larger machine formerly known simply as the Diesel Auto Patrol becomes the No. 11 Diesel Auto Patrol. Spark ignition as well as Diesel models will continue to be available in both sizes.

The new No. 10 Diesel machine weighs approximately 15,600



New "Caterpillar" No. 10 Diesel Auto Patrol

lb. in the tandem drive model and 13,000 lb. with single drive. Both models are provided with four speeds forward and one reverse, the forward speeds ranging from 1.8 to 10 miles per hour.

▼

New Pipe Layer

A new, improved Model 40 Trackson pipe layer, an all-purpose pipe handling machine, was exhibited at the recent International Petroleum Exposition by the Trackson Co., Milwaukee, Wis.

It is designed and built for the McCormick-Deering Model T-40 TracTracTor. It is sturdily constructed for fast, efficient operation. All control levers are located at the driver's fingertips and operations simplified to a minimum.

The side boom is constructed to heavy H-beams with a cast steel header designed for quick attachment and removal of blocks and stiff leg. It is substantially mounted to the rigid tractor frame and pivots on hardened steel, replaceable bushings. The legs of the boom are widespread, enabling it to take side pulls as well those of lifting and lowering. When boom has been raised to a vertical position, a safety stop prevents overthrow or bending.

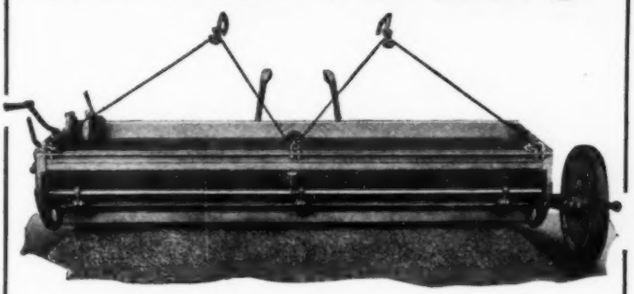
Both load and boom lines raise and lower under power by means of worm driven winches. A separate clutch and brake on the load line drum allows load to be lowered without power, when desired. A special cross drive transmission permits load

New Model 40 Trackson Pipe Layer

Good Roads

CHAMPION N & H

SPREADERS



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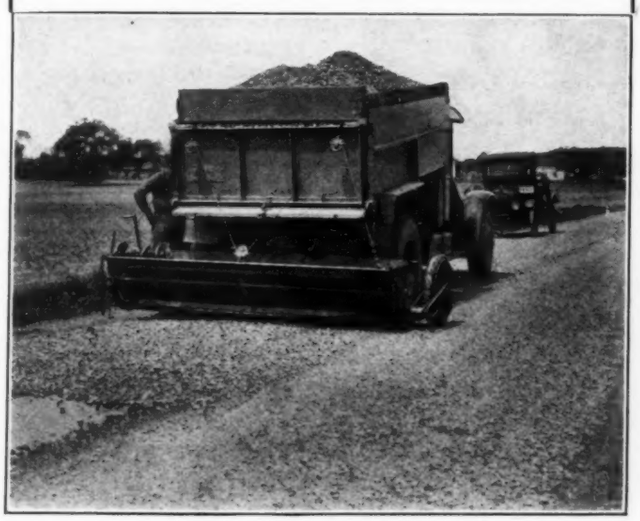

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A third states:
"We have dug up rock almost as large as the bucket. We have increased our yardage more than double." *

*Excerpts from letters in our files.

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"... DIG WITH A PAGE AUTOMATIC"

PAGE ENGINEERING COMPANY
CLEARING POST OFFICE CHICAGO, ILLINOIS

and boom lines to be raised or lowered separately or simultaneously.

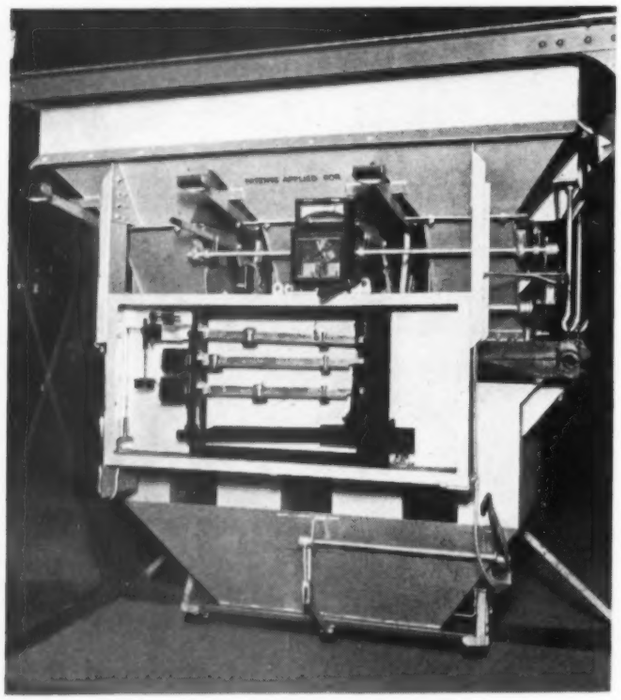
The Trackson transmission, one of the many exclusive features on the Trackson pipe layer, provides three speeds forward and reverse on both boom and load lines.

The Model 40 Trackson Pipe Layer is furnished complete with cable, blocks, stiff legs and 2,500 lb. counterweight.

The manufacturers will send full descriptive bulletin upon request.

New Blaw-Knox Semi-Automatic Weighing Batcher for Three Aggregates

In this 1 cu. yd. semi-automatic weighing batcher for three aggregates, the filling gates are manually opened, but close automatically when the correct weight is reached. An intermediate position of the gate closing permits dribble of the aggregates



New Blaw-Knox Weighing Batcher

prior to the final cut-off. The batcher is equipped with a three beam scale and springless indicator with mercury contacts for automatic closing of the filling gate. Further information about this batcher will be furnished upon request by Blaw-Knox Co., Pittsburgh, Pa.

New Hand-Chain Hoists

The Conco Engineering Works, 863 Jefferson St., Mendota, Ill., is introducing an improved reasonably-priced, spur-geared hand-chain hoist in which precision ball bearings, accurate machining of parts and other features combine to lessen the energy required to move a given load in a given time. This type is used for material handling in capacities from ¼ ton to 6 tons, although other Conco spur-geared hand-chain hoists of similar design are available up to 20 tons' capacity.

Hoists of 3-ton capacity and up are of the double-line type and these have precision ball bearings on the idle sheave axles. It is stated that to lift its rated load capacity one foot, the 1½-ton hoist requires a chain overhaul of 35 ft. and a chain pull of 100 lb.; the 3-ton hoist, 70-ft. chain overhaul and 101-lb. chain pull; the 6-ton hoist, 133.5 ft. chain overhaul and 117-lb. chain pull.

Special effort has been made to make the hoist foolproof. A safety load-chain guide is provided as "jam insurance." It keeps the chain from riding out of the pocket or fouling, or leaving the wheel, no matter from what angle the hand chain is pulled.

The chain is electrically welded with high tensile-strength, elastic-limit and elongation. The hooks are of the "safety" type, drop-forged, heat-treated and tested, and will open gradually under excessive load, allowing time to lower before the hook opens. As an added safety factor in case of overloading, all parts of the hoist in suspension are made of steel.

New Street Lamp Increases Light

A new street lamp with a specially designed refractor, announced by General Electric Co., is stated to shed 90 per cent more light on the street than comparable luminaires of older design.

The unit, known as Form-79R, is an addition to the company's new line of concealed light source luminaires, which direct a maximum of light to the street and thus suppress objectionable glare in upstairs windows and in the eyes of approaching motorists.

By adding the refractor to the concealed light source unit, G. E. engineers have increased the efficiency of the luminaire which is already 55 per cent better than conventional units, to 90 per cent.

The refractor will be spun on the reflector at the factory and become a permanent part of the luminaire. This will keep dust and bugs from entering the lamp and impairing its efficiency.

Underdrive Auxiliary Transmission for Trucks

Introduction of a new auxiliary "underdrive only" transmission to provide a dual axle ratio is announced by H. S. Watson Co., 525 Fourth St., San Francisco, Calif. This two-axle ratio transmission is a new type supplementing the line of three-axle ratio transmissions distributed by the Watson organization.

The unit has a 1.96 ratio underdrive in addition to the direct drive of the truck. This new transmission unit which is installed in back of the factory-equipped transmission of trucks of all makes from one to three-ton capacity, provides eight amplified-power forward speeds.

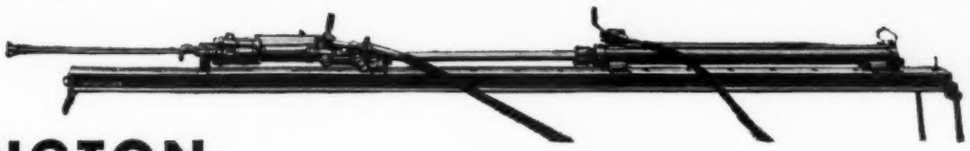
The unit has been especially developed to give underdrive and direct axle ratios to trucks principally operating on short hauls where tremendous power or very slow travel is necessary.

New Sprinkler-Sweeper

A new sprinkler-sweeper has been added to the line of road sweepers of the Frank G. Hough Co., 919 North Michigan Ave., Chicago.

This new machine, which can be pulled by any small tractor or truck, sweeps to the right or to the left. It is powered by its own engine, which operates the brush as well as a ro-

Hough Universal Street Sweeper



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PNEU-FEED *for drilling snake holes*

A modern tool that speeds up drilling operations and conserves man power . . .

- Replaces the wooden plank and manual back-breaking push.
- Can handle steel changes up to 8 feet.
- Peg legs, adjustable for length and position, make it easy to set for position of hole.
- Retracts machine and steel as well as feeds them to the rock.
- One man can handle it... weight with drill, only 170 pounds.
- Adjustable head takes any hand-held drill.
- Uses less than one cubic foot of air per minute.
- Simple and sturdy...a time and money saver.

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Cheaper Dirt-Moving

Sauerman Slackline Cableway Excavating Under - Water Gravel

WHEN you have an excavation job that calls for moving dirt several hundred feet or more, isn't it logical to use a machine that will reach the entire distance and eliminate any re-handling of the dirt.

Sauerman Slacklines and Drag Scrapers will do just that—reach any distance from 100 to 1,500 ft. and handle the digging, hauling and disposal of the dirt in one operation.

SAUERMAN BROS.
488 S. Clinton St. CHICAGO

Sauerman Slackline Scraper at work in Deep Gravel Pit.

Drag Scraper Making a Side-hill Fill.

tary gear pump for supplying the water pressure. Its tank holds 200 gal. of water which is sprayed ahead of the brush. It is stated the machine will sweep, without raising any appreciable amount of dust, at the rate of 5 to 6 miles per hour. Each filling of water is sufficient for from 8 to 10 miles of sweeping.

▼

New 1½-Yd. Shovel

Second in the new 700 series of Diesel powered excavators, announced this year by the Harnischfeger Corporation of Milwaukee, is the Model 705, a full-revolving machine with 1½-yd. capacity. Completely redesigned to take advantage of the newest developments in high tensile alloy steels and the use of arc welding, considerable emphasis has been laid upon weight reduction to obtain a higher ratio of horsepower per pound

Harnischfeger New 1½-Yd. Shovel

of weight, thus reducing the effect of inertia for faster operating speeds with lower fuel consumption.

Standard power on this new 1½-yd. machine is by a 6-cyl. Caterpillar Diesel engine rated at 130 h.p. at 900 r.p.m., although gasoline power is also available. The model 705 is fully convertible for service as shovel, dragline, crane, trench hoe, skimmer or pile driver.

An attractive 16-page booklet covering design and operation of this new machine is now being released. Copies may be had by addressing the home offices of the corporation at Milwaukee. Ask for Bulletin X-4.

▼

New Dodge Dump Truck

The illustration shows the new special Dodge hydraulic dump truck that has been built for quick loading and unloading of various types of loads. By removing two pins, the hinged side and tail gate can be lowered to form a wide platform body. By lowering one side, wheel-barrow loads may be wheeled upon a plank walk to the truck platform. Another feature provided by the lowering of one side is that dirt may be shoveled on or off more easily.

New Dodge Dump Truck

New Cleats Provide 2-Way Traction

Introduced last month by Bucyrus-Erie Co. of South Milwaukee, Wis., is a new cast cleat to be attached to the links of Bucyrus-Erie crawlers on jobs where increased traction is desired. A unique cross-construction provides a two-way traction

New Cast Cleats for Crawler:

that prevents slipping when moving forward and eliminates sliding sidewise when on soft hillsides. The cleats may be used on every link, or every second, third, or fourth link, depending on the ground requirements. They are easily attached—the curved ends of the two sections hook over the outside edges of the links and the two parts are bolted together. Bolting holds the sections together in tension rather than tension and shear, and makes drilling holes in the links unnecessary. A three-point contact assures perfect seating of the cleats and prevents working loose. They are removed by merely unbolting and lifting from links. Sizes are available to fit many of the smaller Bucyrus-Erie machines.

▼

"Smootharc" Welding Electrodes Introduced by Harnischfeger

An entirely new line of coated rods for D. C. welding is now being made and sold through the Harnischfeger Corporation of Milwaukee, manufacturers of P&H-Hansen Arc welding equipment. The present line includes five different types with both high and low rates of fluidity for various types of work in welding in flat, vertical or overhead positions and with ferrous and non-ferrous metals. Service tests show tensile strength of welds from 55,000 to 75,000 lbs. per square inch with various types of rods ranging from 3/32 to 3/8 in. in size. "Smootharc" electrodes are designed primarily to speed up welding operations with a smoother, more easily handled arc and to reduce spatter losses. The new line is described in a new Bulletin (No. R-1), copies of which may be obtained upon request.

▼

New Ditcher Only 4 Ft. Wide Cuts 5 Ft. Deep

Barber-Greene Co., Aurora, Ill., has just announced the new B-G Model 64-B ditcher. The 64-B, the new model, has all of the features of the previous 64 machine with a digging boom for a maximum of 5 ft. deep. The boom is equipped

New B-G Model 64-B Ditcher

with buckets which may be adjusted for 8-in. or 11-in. wide. A 3-ft. 6-in. deep boom is available if desired.

TIME *IS* MONEY!

One Man INSTALLS THE WHEELING DOWEL AND JOINT SUPPORT

● The Wheeling Dowel and Joint Support is a one-piece fabricated sheet steel device, ready to place in position. Five are packed in each crate. Simply remove from the crate and distribute along the work where required. One man completes the installation. You save the time required for driving stakes and the time for removing equipment needed by previous methods . . . there are *no* stakes to drive, *nothing* to take out after concrete is poured.

● This new Dowel and Joint Support proved a complete success the day it was introduced. On the basis of savings of delays in operations alone it merits your favor . . . if time on the job means money, save useless delays with the Wheeling Dowel and Joint Support. When cross section, width of slab and total lineal feet of expansion and contraction joints are furnished, quotations can be sent by return mail.

Wheeling

NO STAKES *to Drive* NO DEVICE *to Remove*

WHEELING CORRUGATING COMPANY

WHEELING, WEST VIRGINIA

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CHICAGO ST. LOUIS LOUISVILLE ATLANTA MINNEAPOLIS DETROIT

41 years old— and still "the tops"

Photo taken April, 1936, of Glenarm, from 14th to 19th Street, Denver, Colorado . . . paved with **Trinidad Native Lake Asphalt** in 1895—still in excellent condition.

It takes mighty good paving to stand the heavy, steady traffic of 41 years—particularly a prominent street like Glenarm, in Denver. But here's the proof that **Trinidad Native Lake Asphalt** is as good as we say it is . . . proof that you can see today if you're anywhere near Denver.

And not only does **Trinidad Native Lake Asphalt** last for years and years as a *new* pavement—but you can cover present old concrete, brick, granite or wood-block pavements and make *a new street for the price of an asphaltic top.*

It will pay to investigate. Send the coupon below, NOW.

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☐ TRINIDAD NATIVE LAKE ASPHALT
For Hot or Cold Mix Sheet Asphaltic Concrete Pavements.

☐ BARBER BRAND EMULSIFIED ASPHALTS
Used Cold for Penetration, Pre-Mix Road Mix (Mixed in Place) and Surface Treatment Work.

☐ BARBER BRAND LIQUID ASPHALTS
For Cold Surface Treatment—for Hot Surface Treatment.

☐ BARBER BRAND WINTER COLD PATCH
A Cut-Back Asphalt for Use in Patching and Maintenance Work in Cold Weather.

☐ GENASCO CRACK FILLER
For Maintenance of Concrete Roads.

☐ GENASCO BLOCK AND JOINT FILLER
For Brick and Granite Block Streets. For Filling Joints in Concrete Roads.

☐ CURCRETE
An Emulsified Asphalt for Curing Concrete Highways.

With a total overall width of only 48 in., the new Barber-Greene is able to dig in the closet quarters. The relatively miniature size of the ditcher makes it easy to travel from job to job on a small trailer. Being full crawler mounted it loads and unloads itself.

The 64-B incorporates all of the standard Barber-Greene ditcher features including: automatic overload release sprocket which slips when an overload occurs and resets itself, full crawler mounting, three point suspension, vertical boom, milling action digging, self-cleaning buckets, instantly reversible spoil conveyor, etc.

Complete information on this new ditcher will be sent to any one writing Barber-Greene Co., Aurora, Ill.

▼

New Grapple

A new Owen Type RA grapple has been placed on the market by The Owen Bucket Co., Cleveland, O.

The most distinguishing feature of this new Owen grapple, as compared with the 4-tine grapple of conventional design, is the independent action of its tines. Instead of moving simultaneously toward the center in closing, any tine is capable of acting independently of the other three tines. This patented action, obtained by combining toggle operated tines and arm controlled tines, cause all four tines to grip any stone regardless of its shape, with practically equal pressure.

New Owen Type RA Grapple

This original action is claimed to enable the operator to place the grapple more easily and quickly and to handle greater quantities of stone with a factor of safety never before attained.

This is the first formal announcement of this new grapple but units have been in operation in various sections of the country for several months. Grapples with capacities from 3 to 60 tons are illustrated and described in the new bulletin just off the press.

▼

New 12-Yard Carryall Scraper

A new model 12-yard carryall scraper, the Type "Y," for use with RD-8 Caterpillar tractors, has just been announced by R. G. LeTourneau, Inc., Peoria, Ill., and Stockton, Calif.

In design the new model is quite similar to the company's former 12-yard carryall. It is cable-controlled by means of a 2-drum LeTourneau power control unit mounted at the rear of the pulling tractor. It embodies the same positive, accurate unloading method, namely, use of a sliding tailgate to force material out of the bowl. The cutting blade of 10 ft. in width, bowl dimensions, and dirt-carrying capacity are the same.

LeTourneau New 12-Yd. Scraper

The major change is in the tire size, which has been increased from 13.50x20 to 18.00x24. The larger tires greatly reduce draft on the tractor and provide a much larger ground contact. Four 18.00x24 low-pressure tires are standard equipment on the Type "Y," but duals on the rear and singles in the front, or duals both front and rear, are optional at extra cost.

To accommodate the larger tires, the front yoke has been heightened, resulting in greater clearance and easier turning. The return spring assembly is housed in the tailgate itself, and the reserve cable reel is mounted atop the tailgate, making it handier to pull new cable through the sheaves. The ball bearings in these sheaves are especially designed with a built-in, absolutely dust-proof seal, which insures free rolling cable and long bearing life.

As with the former LeTourneau 12-yard models, the Type "Y" can be operated in tandem behind a single tractor equipped with a 4-drum power control unit. The rear drawbar for tandem hookup is standard equipment.

▼

New Tandem Drive Speed Patrols

Announcement has been made of the addition of tandem drive speed patrols to the line of Allis-Chalmers road machine. The new patrols come in two sizes, one having 42 H.P. and the other 54 H.P.

Constructed along the trend of modern automotive design the new A-C tandem patrols are stated to have many new and outstanding features such as wide front axle for greater stability—wear take-up provision at all vital points—ball and socket connections—and hydraulic brakes of the internal expanding type.

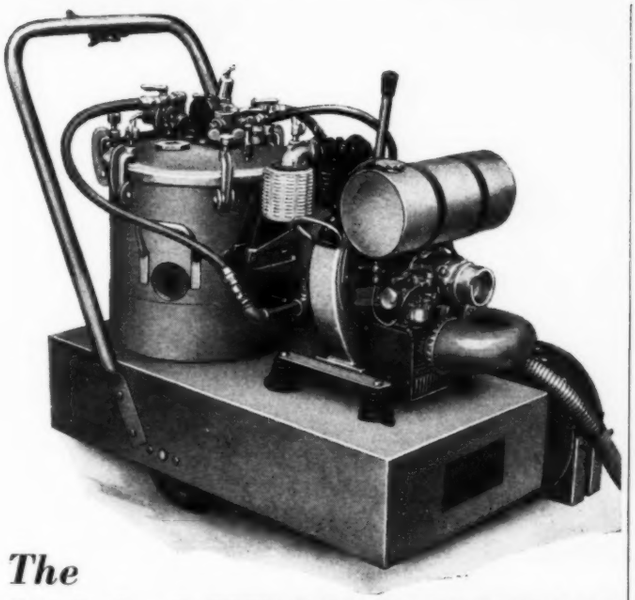
Allis-Chalmers New Patrol

A complete range of tire equipment is available including both low and high pressure types in 4 or 8 wheel tandem assemblies to meet a wide variety of working conditions.

The model 42 weighs 15,350 lbs. and the model 54 weighs 17,130 lbs. Speeds range from 2.3 to 10 miles per hour. An extra long blade base allows for maximum effective blade pressure and a huge circle, 5-ft., 4-in. in diameter, provides for rigid moldboard mounting and "chatter-proof" performance.

A gear drive enclosed in an all-welded case transmits power from the drive shaft to the final drive axles. After exhaustive tests Allis-Chalmers found a gear drive to be the most satisfactory because it eliminates troubles such as noise, stretch, rapid wear and the need for constant adjustment which are encountered where chain drives are used.

A folder illustrating and describing the new machines can be obtained from Allis-Chalmers Mfg. Co., Milwaukee, Wis.



The Littleford TRAF-O-SPRAY

Paints better traffic lines faster; no slopping or fogging; uses less paint; fewer man hours per mile of line than with any other method. Use the Traf-O-Spray. It sprays any traffic paint or lacquers onto hard surfaces evenly without requiring hand retouching. Ask for full particulars on the Traf-O-Spray.

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454 E. Pearl St. CINCINNATI, OHIO

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DeWitt Operated Hotels feature
Unusually Comfortable Rooms at Reasonable Rates, and the finest of Food and Beverages, Carefully Prepared and Served.

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The use of Blaw-Knox Road Building Equipment provides the short cuts to economy which are essential to profits in today's scheme for building roads.

How will this equipment fit into your road building operations?

Just ask Blaw-Knox!

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WITH THE MANUFACTURERS

Twenty Silver King Highway Mowers for Ohio State Highway Department

Twenty Silver King highway mowers manufactured by the Fate-Root-Heath Co., Plymouth, O., were delivered recently to the Ohio State Highway Department for use in the Ashland, Chillicothe and Marietta highway divisions. Before purchasing the mowers, 26 representatives of the highway department from the three respective divisions visited the Fate-Root-Heath Co. plant and witnessed the Silver King tractor and mower units in process of construction.

Twenty Silver King highway mowers photographed on the public square just prior to shipment to three of the Ohio State Highway Divisions. The tractors and mowing units were painted a bright yellow—regulation color of the state highway department.

The Silver King highway mower was developed by practical engineers who are thoroughly acquainted with the requirements needed for an efficient and serviceable mower. Many new and practical features are included. The mower has a high lift which permits free and easy cutting over curbs. The cutter bar raises and lowers to a 30 degree angle. Other features claimed are: Clear road vision, one man control, high speed travel, close cutting to obstructions and low maintenance costs.

▼

Goodyear Completes Its First 250,000,000 Tires

With production of its first 250,000,000 tires completed, the Goodyear Tire & Rubber Company has started on its second quarter-billion casings, according to announcements from company headquarters in Akron, O.

President Paul W. Litchfield and other company officials assisted in the ceremonies as the tire bearing No. 250,000,000 was built up in the tire room and followed it down to the pits where it was cured. President Litchfield himself applied the tread to the tire and inspected it when it was lifted from the molds.

Particularly fitting, in the opinion of Goodyear officials, was the fact that the tire was a Double Eagle Airwheel, Goodyear's recently announced "super" tire, in the popular 6.00-16 size for lower-priced cars. Also significant to Goodyear men was the fact that the tire bearing No. 250,000,001, starting the company's second quarter-billion, was an all-traction tractor tire for farm use.

Officials of The Goodyear Tire & Rubber Co., Compare the Double Eagle Airwheel That Marked Completion of a Quarter-Billion Tires by the Company, Recently, with an All-Weather Tread Tire of 10 Years Ago. Left to Right Are R. S. Wilson, Vice President and Sales Manager; President Paul W. Litchfield; L. E. Judd, Director of Advertising and Public Relations, and L. H. Shepherd, Manager of the Truck Tire Department.

Manufacture of the 250,000,000 tires consumed approximately 1,200,000,000 lbs. of cotton, or 2,400,000 bales, and approximately 2,750,000,000 lbs. of crude rubber, which on the present production schedule would amount to all the rubber the world could produce in a year and a half.

▼

Marion Opens Texas Office

To better facilitate the handling of increased activities in the Southwest, the Marion Steam Shovel Co., Marion, Ohio, is opening an office in San Antonio, Tex. Paul E. Piersol will be in charge.

Temporarily, Mr. Piersol's headquarters will be with Motor Equipment Corporation, 419 N. Flores St. This arrangement will be in effect until a suitable permanent location has been established.

Motor Equipment Corporation has recently taken over the distributorship of Marion excavators for Texas and New Mexico, which will embrace Marion's Southwestern territory.

Paul Piersol

▼

Corrugated Steel Sheet Piling Corp. Formed

The Corrugated Steel Sheet Piling Corporation has recently been formed and has taken over the steel sheet piling department of the Youngstown Pressed Steel Co. at Warren, O., and also the business of the National Steel Piling Exchange, Chicago. The offices are at 228 North La Salle St., Chicago, Ill.

▼

Kahn Now Vice President Republic Steel

Julius Kahn, who has been president since his founding of Truscon Steel Corporation three years ago, has resigned his position to become vice-president in charge of Product Development of Republic Steel Corporation, Cleveland, O.

Forrest H. Ramage has been promoted from assistant manager of the Advertising and Sales Promotion division to sales promotion manager and will work in conjunction with the new Product Development Division.

Stanley A. Knisely, formerly manager of the Advertising and Sales Promotion division, has been named director of ad-

"There's A Difference"

FLEX-PLANE Finishing Machine with wide screed, equipped for screeding forward and backward, will surprise you. Finishers 3 to 50 feet wide.

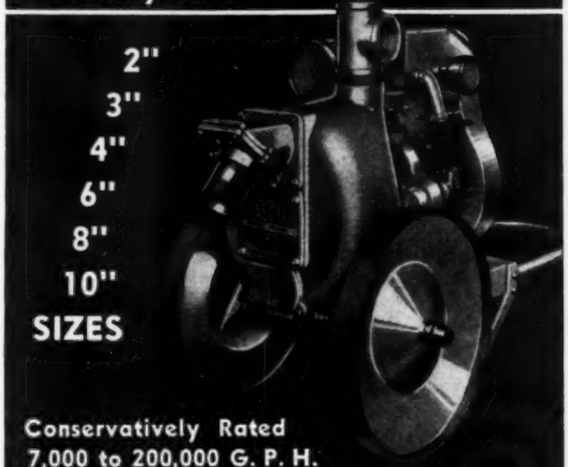
Headquarters for Finishing Machines, Joint Installing Machines, Combination Dowel Rod and Expansion Joint Spotters, etc.

• •

FLEXIBLE ROAD JOINT MACHINE COMPANY
WARREN, OHIO

JAEGER "SURE PRIME" PUMPS

Fastest 100% Automatic Prime — Greater Efficiency at Any Lift



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7,000 to 200,000 G. P. H.

New Catalog and Prices Will Tell You Why Jaeger Pumps Outsell All Others — Write for It.

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223 Dublin Ave., Columbus, Ohio

Most Outstanding Location in- MINNEAPOLIS

Everything at your fingertips - business, shopping and amusement centers. Real comfort — real luxury — at low cost. And food to delight the most jaded palate in the Dining Room and Coffee Shop

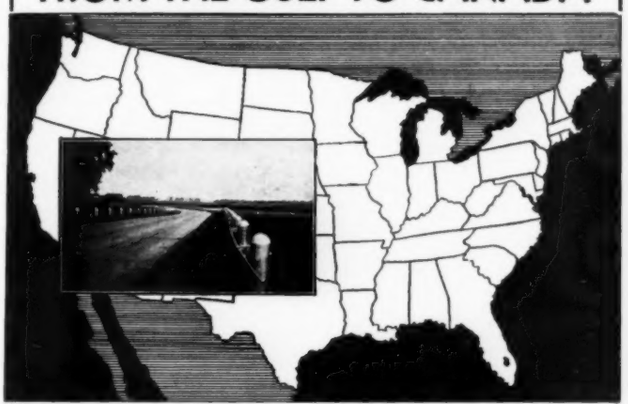
Complete Garage Facilities
Theodore F. Stelten – Manager

Rates from $1.50

ANDREWS HOTEL

FOURTH STREET AT HENNEPIN AVENUE

FROM COAST TO COAST FROM THE GULF TO CANADA



WEJ-LOCK GUARD RAIL EQUIPMENT MEETS ALL STATE SPECIFICATIONS

Wej-Lock guard rail equipment has been approved in every state in the Union and is made to exact state specifications. Write for quotations on Wej-Lock products for cable guard rail.

Cable Ends	Take Up Splices	Anchors
Cable Splices	Automatic Spring Assembly	Tools
Take Up Fittings	Super Guard Rail	Offsets

Everything for Cable Guard Rail

WEJ-LOCK CO. CENTRALIA MISSOURI
DIVISION OF A. B. CHANCE CO.

vertising with direct supervision of all advertising of the corporation and its subsidiaries. Chester W. Ruth has been made assistant director of advertising.

▼

Chicago Pneumatic Changes Pittsburgh Offices

Effective June 1, 1936, the address of the Pittsburgh, Pa., office of the Chicago Pneumatic Tool Co., New York, is 810 Chamber of Commerce Bldg., Pittsburgh, Pa.

▼

Cyrus H. McCormick Dies

Cyrus H. McCormick, retired chairman of the board of directors of the International Harvester Company, died June 2 at his home, "Walden," in Lake Forest, Ill., where he was stricken with a heart attack May 30.

Mr. McCormick was a principal factor in the formation of the Harvester Company in 1902 and its president from that time until 1918 when he became chairman of the board, which office he held until his retirement in September, 1935.

In 1902 the McCormick Company united with others to form the International Harvester Company, and Mr. McCormick was elected the company's first president.

During his 33 years as president and chairman of the Harvester Company Mr. McCormick pioneered many activities in the Harvester organization which have borne abundant fruit in their application to industry in general.

Cyrus H. McCormick was born in Washington, D. C., May 16, 1859, the eldest son of Cyrus Hall McCormick, inventor of the reaper, and Nancy Maria Fowler McCormick. He attended the Chicago public schools and entered Princeton University as a member of the class of 1879. After college he entered the McCormick Harvesting Machine Company, of which his father was the head.

▼

Salditt Returns from Mexico

Mr. Frederick Salditt, export sales manager of the Harnischfeger Corporation, Milwaukee, has just returned from a six-weeks' business trip to Mexico, where he reports general business conditions to be very encouraging. In addition to the vigorous program of highway extension, progress in railway construction and irrigation projects, considerable residential building indicates a period of prosperity on the rise and an active market for American products within the next few years, according to Mr. Salditt.

NEW LITERATURE

Toncan Iron Pipe—The fourth edition of "Toncan Iron Pipe for Permanence" is being distributed by Republic Steel Corporation, Cleveland, O. This new 64 page book is profusely illustrated with test charts and tables and incorporates new sections dealing with threading, air conditioning, industrial maintenance and process uses, and brewing and distilling applications. Augmenting the test charts is a large list of photographs showing the increasing applications for which this type of pipe is being utilized.

Industrial Compressors and Vacuum Pumps—Ingersoll-Rand catalog 7502-E, recently issued, covers the company's "Type 30" line of industrial compressors and vacuum pumps. It has 28 pages and cover. Compressors single and two-stage, ¼ to 15 hp., 1.2 to 102 cu. ft. per min., pressures to 1,000 lbs., vacuums to within 35" (Hg.) of barometer. Units mounted on horizontal and vertical tanks are shown; also units unmounted, and mounted on carriages. A copy may be obtained from Ingersoll-Rand, 11 Broadway, New York City.

New Drainage Products—"Drainage Products" is the title of a 48-page catalog recently published by the Armco Culvert Manufacturers' Association. The principal products described include Armco corrugated pipe, paved invert pipe, standard and helcor perforated pipe, connections and fittings, multi plate pipe and arches, part circle culverts and Calco drainage gates. Besides, there is current information on "where drainage is needed," "uses of Armco Ingot Iron Pipe," strength, durability and installation economy; also, how to determine culvert sizes. Free copies may be obtained by addressing the Armco Culvert Manufacturers' Association, Middletown, O., or any of its member companies.

Power Transmission Equipment—The Link-Belt Co., Chicago, has just published a new 208-page catalog No. 1500 devoted exclusively to power transmission equipment. The new book features the recently announced line of Link-Belt antifriction roller bearing units, as well as an entirely new group of streamlined babbitted bearings, several new types of take-ups, and many other new products. The book contains many illustrations, gives dimensions, weights and list prices, and contains a cross reference index for convenient use of engineers and plant managers. The new book is offered to anyone interested in power transmission equipment. The reader's request may be addressed to Link-Belt Co., 2410 W. 18th St., Chicago, Ill.

Subdrainage—Especially timely, in view of the current extensive damage to highways and streets by water and frost action, is a new 32-page bulletin entitled "Subgrade Drainage for Modern Roadways," published by the Armco Culvert Manufacturers' Association. This bulletin summarizes the annually recurring damage and stresses the need for engineers and officials to guard against future criticism by remedying existing conditions and providing stable subgrades on all new construction. The relation of soil studies to the problem is briefly described. Drainable and undrainable soils are defined. Various subgrade treatments are described including the use of admixtures and porous sub-bases. Drainage is divided into two classes—interception drainage and drainage to lower the water table. Typical cross-sections and recommended installation practices are shown, as well as numerous other illustrations. Copies of this bulletin, H-36, may be obtained free of charge by addressing the Armco Culvert Manufacturers' Association, Middletown, O.

Paving Equipment—A 58-page catalog illustrating and describing its line of paving equipment has been issued by the Jaeger Machine Co., 223 Dublin Ave., Columbus, O. The equipment illustrated and described includes concrete finishers, combined finishers and spreaders, bituminous pavers, road builders, spreader boxes, concrete spreaders, steel road forms, sub-graders, grade rooters, road pumps, concrete mixers, etc. Over 100 interesting action pictures of modern road building are shown in the catalog. Write the company at Columbus for your copy.

Electric Driven Compressors—Ingersoll-Rand Co. has issued a bulletin illustrating and describing its new electric-driven, 2-stage, air-cooled portable compressors. The compressors are driven by either A.C. or D.C. motors. Starting equipment is of the magnetic type to operate from a push button. Five models, from 15 to 75 hp. and numerous types of mountings are available. Copies of Bulletin No. 2198 may be obtained from Ingersoll-Rand Company, 11 Broadway, New York City.

Angledozer—R. G. Le Tourneau, Inc., Peoria, Ill., and Stockton, Calif., has just issued a folder illustrating and describing the Le Tourneau angledozer. Various features of equipment are pictured and described, and specifications are given. Copy of the folder can be obtained from the company.

Crushing Plants—A 16-sheet broadside describing its straight line crushing plants has been issued by the Iowa Manufacturing Co., Cedar Rapids, Ia. The broadside is profusely illustrated not only with pictures of the equipment itself, but also job pictures. A detailed description and specifications are given. Address the company at Cedar Rapids for a copy.

Tractor—The Allis-Chalmers Model "L" tractor is described in detail in a catalog issued by the Allis-Chalmers Manufacturing Co., Milwaukee, Wis. The catalog is generously illustrated and has detailed information and specifications. A copy can be obtained by writing the tractor division of Allis-Chalmers at Milwaukee.

Pumps—The Jaeger Machine Co., 223 Dublin Ave., Columbus, O., has issued a 38-page catalog describing its complete line of pumps, including self-priming centrifugals, jetting pumps, triplex pumps, diaphragm pumps, and well point systems. Details of the pumps are illustrated and described, and specifications are given. Useful hydraulic tables are included in the catalog as well as information telling how to determine pump size and type for any particular job. For your copy write the company at Columbus.

Concrete Mixers—A 38-page catalog devoted to its line of mixers has been published by the Jaeger Machine Co., 223 Dublin Ave., Columbus, O. Each machine is illustrated and described, and specifications are given. Ask for Catalog M 36.